

FIFA-EAST VSTS CENTENNIAL PARK

56 Centennial Park Road
Toronto, ON

Architectural | Structural | Mechanical | Electrical | Geothermal |
Landscape | Field Electrical | Low carbon | Specifications

Issued for Permit and Tender
November 2024

Project No. 2318E

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Low Carbon Consultant
JDX Advance Services Inc.

- .1 Refer to Project Manual, Section 00 01 10 - Table of Contents, for indication of document responsibility (DR). Abbreviations for entity responsible for document preparation are as follows:
- .1 A - Denotes documents prepared by Architect.
 - .2 S - Denotes documents prepared by Structural Engineer.
 - .3 HC - Denotes documents prepared by Hardware Consultant.
 - .4 M - Denotes documents prepared by Mechanical Engineer.
 - .5 E - Denotes documents prepared by Electrical Engineer.
 - .6 FE – Denotes documents prepared by Field Electrical Engineer
 - .7 G - Denotes documents prepared by Geothermal Consultant.
 - .8 LA – Denotes documents prepared by Landscape Architect
 - .9 O - Denotes documents prepared by Owner.

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1 GEOTECHNICAL INVESTIGATION REPORT

1. A copy of a report of subsurface investigation and geotechnical evaluation made at the building site is appended to this Section, titled as follows:

Final Geotechnical Investigation Centennial Park Toronto, Ontario

Prepared by Orbit Engineering Ltd.

August 15, 2023 (Revised April 18, 2024)

- .1 Bidders are required to submit their bids upon the express condition that they shall have satisfied themselves before bidding, by personal examination of the location of the proposed works, or by such other means as they may prefer, as to the actual conditions and requirements of the Work.
- .2 The sub-surface investigation information indicates properties of the soils and recommendations for the design of foundations and was prepared primarily for the use of the Consultant. The recommendations given shall not be construed as a requirement of the Contract unless also contained in the Contract Documents.
- .3 This report does not form part of the Contract Documents.
- .4 This report, by its nature, cannot reveal all conditions that exist or can occur on the site. Should sub-surface conditions, in the opinion of the Consultant, be found to vary substantially from the report, changes in the design and construction of foundations will be made, with resulting credits or expenditures to the Contract Price accruing to the Owner.
- .5 This subsurface investigation is furnished by the Owner to the Contractor and is included in these specifications only for the ease of reference. The Owner and the Consultant assume no responsibility for the accuracy or completeness of the information contained in the report.
- .6 Direct all questions pertaining to the geotechnical investigation to the report's author.

END OF SECTION

**FINAL GEOTECHNICAL INVESTIGATION
CENTENNIAL PARK
Toronto, Ontario**

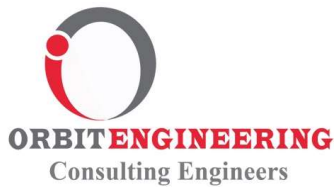


**Prepared for:
The City of Toronto**

**By:
Orbit Engineering Limited**

Project No. OE231465GG

August 15, 2023 (Revised April 18, 2024)



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Email: mark.goulart@toronto.ca

Attention: Mark Goulart

**RE: Final Geotechnical Investigation
Centennial Park, Toronto, Ontario**

Enclosed please find the geotechnical investigation report related to the above noted site.

For and on behalf of Orbit Engineering Limited

A handwritten signature in blue ink, appearing to read "Hafiz Muneeb Ahmad". The signature is fluid and cursive, with the first letters of the first and last names being capitalized and prominent.

Hafiz Muneeb Ahmad, M.Sc., M.Eng., P.Eng., C. Eng, QP_{ESA}
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EXECUTIVE SUMMARY

A final geotechnical investigation based on six boreholes (BH101 to BH106 drilled in Jan. 2024) and twenty-two boreholes (BH1 to BH22 drilled in April 2023) was carried out for the proposed upgrades in the Centennial Park, Toronto, Ontario.

The purpose of this investigation was to assess the subsurface conditions at the borehole locations and from the findings in the boreholes make geotechnical engineering recommendations regarding the site preparation for the upgradation of existing sports field & parking lot.

The topsoil thickness generally ranged from 150mm to 300mm at the borehole locations excluding boreholes (BH1, BH2, BH3, BH7, BH8, BH11, BH13, BH17, BH19 & BH21) where pavement structure (i.e., asphalt ranged approximately 75 mm to 100 mm underlain by granular fill with thickness varying from 120mm to 350mm). It should be noted that the thickness of the topsoil and asphalt explored at the borehole locations may not be representative for the site and should not be relied on to calculate the amount of topsoil and asphalt quantities at the site.

Underneath the topsoil and pavement structure, fill material was encountered in all boreholes and extended to depths varying from 0.4 to 1.7m below the existing ground surface. The explored fill generally consisted of sandy silt, some clay, trace gravel, organics, rootlets, and topsoil like materials, and in a state of loose to compact. The native soil underneath the fill was consisted of glacial till deposit. The till deposit predominantly consisted of compact to very dense silty sand till with some clay, greyish brown and extended to a maximum explored depth of 6.7m as observed in borehole BH7, whereas shale (assumed bedrock surface) was encountered at borehole locations (BH101 to BH106, BH1, BH13 & BH21) at depths varying from 2.3m to 6.1m below the existing ground surface.

During drilling and at the completion of drilling, the short term (not stabilized) groundwater level was not observed in boreholes (BH101 to BH106) drilled in Jan. 2024, whereas groundwater was observed at approximate depths of 0.9m to 6.2m in boreholes (BH1 to BH22) drilled in April 2023. Perched water may be encountered in excavated areas during wet seasons. A perched water condition can occur due to the accumulation of surface water in the fill deposits. It should be noted that groundwater levels vary and are subjected to seasonal fluctuations and can respond to major precipitation events. The depth of groundwater table can also be influenced by the presence of underground features such as utility trenches.

Based on the borehole investigation, during drilling and at the completion of drilling, combustible gases were not detected within the detection range of the instrument (i.e. Model GT-2400 manufactured by GASTECH).



The Sport fields can be supported on grade, provided all topsoil, organics, existing loose fill are removed to a minimum depth of 0.6m below the existing grade and the exposed surface thoroughly proof rolled by using a loaded truck or a roller with a minimum rated capacity of 8 tons. Any soft spots or unstable areas revealed during proof rolling must be sub-excavated and re-engineered.

The floor slab without basement can also be supported on grade provided the existing fill and surficial weak/softened native soil are removed and the base thoroughly proof rolled, refer to Section 4.6 for details.

The preliminary sport areas design details are presented in the Section 4. To provide effective surface drainage and prevent subgrade softening, the subgrade should be free of depressions and sloped preferably at a minimum grade of two percent toward the perimeter drainage system or under floor drainage system as explained in Section 4.3.

Foundations for light poles or similar structures in the sport areas can be supported on conventional spread footings or short drilled piers founded on the undisturbed native soils at minimum depth of 1m from the existing grades at borehole locations for a geotechnical reaction of 150 kPa at the Serviceability Limit States (SLS) and a factored geotechnical resistance of 225 kPa at the Ultimate Limit State (ULS).

Based on the borehole information and according to Table 4.1.8.4.A of OBC 2012, the subject site for the proposed upgradations can be classified as Class 'D' for seismic site response. Accordingly, the foundation factors F_a can be obtained from Table 4.1.8.4.B and F_v from Table 4.1.8.4.C for the design of the proposed structure. Consideration may be given to conduct an earthquake site assessment with the use of in-situ testing of the seismic characteristics (i.e., Geophysical testing) which may lead to an improved site classification, if required.

Based on limited chemical testing to-date, the on-site soil materials are free from potential environmental impacts and meet the soil quality parameters for re-use on site minimum at 1.5m below existing grade or for disposal at RPI and ICC sites permitted to accept fill.



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1 INTRODUCTION

Orbit Engineering Limited (Orbit) was retained by City of Toronto to undertake a final geotechnical investigation for the proposed upgradations of existing sport fields and parking lot, located at Centennial Park, Toronto, Ontario. The site plan and approximate location of proposed boreholes are shown on **Drawings 1** and **1A** respectively.

The current work is conducted in accordance with our proposal OE231465GG, dated December 14, 2023, under the contract No. 47024684 by the City of Toronto. Authorization to proceed was issued to orbit on December 18, 2023 (SAP# 9595744).

The previous work was conducted in accordance with our proposal OE231465GG, dated March 21, 2023, under the contract No. 47024684 by the City of Toronto. Authorization to proceed was issued to orbit on Mar 27, 2023 (CRO # 9534190).

The purpose of this investigation was to assess the subsurface conditions at twenty- eight (28) borehole locations (BH101 to BH106 drilled in Jan. 2024 and BH1 to BH22 drilled in April 2023), and from these field findings make geotechnical engineering recommendations regarding the subgrade preparation for the sport fields Area construction, building structures, parking lot and drainage issues.

This report is provided on the basis of the terms of reference presented above and on the assumption that the design will be in accordance with the applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, this office should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations of this office can be relied upon.

The site investigation and recommendations follow generally accepted practice for geotechnical consultants in Ontario. The format and contents are guided by client specific needs and economics and do not conform to generalized standards for services. Laboratory testing for most part follows ASTM or CSA Standards or modifications of these standards that have become standard practice.

This report has been prepared for City of Toronto, their engineers and designers. Third party use of this report without Orbit consent is prohibited. The limitation conditions presented in **Appendix A** form an integral part of the report and they must be considered in conjunction with this report.



2 FIELD AND LABORATORY WORKS

Prior to drilling operations, underground utilities were cleared at the borehole locations by representatives of the public utilities company working with personnel from Orbit. A private locator firm was also engaged to confirm that the borehole locations were clear from the underground services.

A total of twenty-two (22) boreholes were drilled on 03 April 23, 06 April 23, 10 April 23, 11 April 23 & 12 April 23 extending to depths varying from 2.4m to 6.7m below the existing ground surface, with continuous-flight solid stem augers by a drilling sub-contractor under the observation of Orbit personnel and by portable drilling equipment. The approximate borehole locations of current and previous boreholes are shown on **Drawing 1A**.

Soil samples were retrieved continuously with a 50 mm O.D. split-barrel sampler driven with a hammer weighing 63.5 kg and dropping 760mm in accordance with the Standard Penetration Test (SPT) method (ASTM D1586) and also samples were retrieved with a 50 mm O.D. split-barrel sampler driven with a 31.75 kg (manual drilling) and dropping 760 mm. The blow counts recorded with a hammer weighing 31.75 kg were converted to equivalent Standard Penetration Test (SPT) values.

Boreholes (BH101 to BH106) were drilled in Jan. 2024 and boreholes (BH1-BH22) were drilled in April 2023. The results of these tests (SPT “N” values) are presented on the borehole logs in Drawings (A1 to A6 & 2 to 23) respectively.

Combustible gases were measured during drilling and in the open boreholes at the completion of drilling using a combustible vapour meter (Model GT-2400 manufactured by Gastech).

The samples were logged in the field and returned to the Orbit’s laboratory for detailed examination by the project engineer and for subsequent laboratory testing.

All SPT soil samples were submitted to Orbit’s laboratory for natural moisture content determination, the results of which are presented on the borehole logs in **Drawings (A1 to A6 & 2 to 23)**. In addition, select soil samples were tested for grain size distribution (sieve and/or hydrometer analyses) and the results of which are presented in **Appendix B** and the borehole logs.

3 SITE AND SUBSURFACE CONDITIONS

The project site is located at the south side near the intersection of Eglinton Avenue West and Centennial Park Blvd. The approximate site location plan is presented on **Drawing 1** for details. The existing ground surface elevations were not provided by client while writing this report.



The approximate borehole locations are shown on **Drawing 1A**. Notes on sample descriptions and the general features of fill material and glacial till are presented on **Drawing 1B**. **Drawings A1 to A6 and 2 to 23** provide detailed subsurface conditions at the locations of boreholes (BH101 to BH106 and BH1 to BH22) on the borehole logs. The borehole logs indicate the subsurface conditions only at the borehole locations. Note the material boundaries indicated on the attached logs are approximate and based on visual observations. These boundaries typically represent a transition from one material type to another and should not be regarded as an exact plane of geological change. It should be pointed out that the subsurface conditions will vary across this site. The soil and groundwater conditions are summarized as follows.

3.1 Soil Conditions

The soils explored in the boreholes generally consisted of surficial topsoil, asphalt, fill and native soil layers and shale bedrock.

3.1.1 Topsoil/Pavement

The topsoil thickness generally ranged from 150mm to 300mm at the borehole locations excluding boreholes (BH1, BH2, BH3, BH7, BH8, BH11, BH13, BH17, BH19 & BH21) where pavement structure (i.e., asphalt ranged approximately 75 to 100 mm underlain by granular fill with thickness varying from 120mm to 350mm). It should be noted that the thickness of the topsoil and asphalt explored at the borehole locations may not be representative for the site and should not be relied on to calculate the amount of topsoil and asphalt quantities at the site.

3.1.2 Fill

Underneath the topsoil, fill material was encountered in all boreholes and extended to depths varying from 0.4 to 1.7 m below the existing ground surface. The explored fill generally consisted of sandy silt, some clay, trace gravel, organics, rootlets, and topsoil like materials, and in a state of loose to compact.

3.1.3 Native Soils

The native soil underneath the fill was consisted of glacial till deposit. The till deposit predominantly consisted of compact to very dense silty sand till with some clay, greyish brown and extended to a maximum explored depth of 6.7m as observed in borehole BH7, Grain size distribution tests were also carried out on selected native samples as (BH1 SS3 and BH7 SS5). The results are shown on the borehole logs and also Figure B1 (attached in **Appendix B**) and is summarized as follows:

Gravel:	4 – 12%
Sand:	45 - 56 %
Silt:	26- 37 %
Clay:	4 - 16 %

Based on the grain size results, the till deposit is generally classified as silty sand till.



3.2 Groundwater Conditions

During drilling and at the completion of drilling, the short term (not stabilized) groundwater level was observed in boreholes at approximate depths of 0.9m to 6.2m. Perched water may be encountered in excavated areas during wet seasons. A perched water condition can occur due to the accumulation of surface water in the fill deposits. It should be noted that groundwater levels vary and are subjected to seasonal fluctuations and can respond to major precipitation events. The depth of groundwater table can also be influenced by the presence of underground features such as utility trenches.

3.3 Grain Size Distribution

As presented in **Table 3.1**, samples from the native deposit were used to assess the grain size distribution of the soil materials. The results of these samples are provided in **Table 3.1** and Figure B1(Appendix B).

Table 3.1 Grain Size Distribution and Plasticity of Soil Samples

Sample No.	Depth (m)	Grain Size Distribution			
		Gravel (%)	Sand (%)	Fines*	
				Silt (%)	Clay (%)
BH1-SS3	1.5-2.1	6	56	26	12
BH7-SS5	3.1-3.7	7	45	37	11
BH13-SS2	0.8-1.4	12	51	33	4
BH18-SS3	1.5-2.1	4	54	26	16

* Presents passing the 0.075mm sieve (Silt + Clay)

3.4 Combustible Gases

Based on the borehole investigation, during drilling and at the completion of drilling, combustible gases were not detected within the detection range of the instrument (i.e, Model GT-2400 manufactured by GASTECH).



4 DISCUSSION & RECOMMENDATIONS

4.1 Frost Susceptibility

The frost depth penetration in this area is 1.2m. Based on the grain size analysis and using the Ministry of Transportation (MTO) category for frost susceptibility soils, the on-site fill and native soils deposits would be classified as moderate susceptible to frost heaving.

4.2 Subgrade Preparation

As part of the subgrade preparation for the construction of sport fields Area, the subgrade should be stripped of all topsoil and organic fill materials (if any) to a minimum depth of 0.6m below the existing grade and the base then should be thoroughly proof rolled by using a loaded truck or a roller with a minimum rated capacity of 8 tons. Unstable areas or areas with excessive topsoil /organic materials (if encountered) should be further sub-excavated and bridged by using clean fill materials similar to adjacent areas. The fill required to raise the grade can consist of inorganic soil, placed in shallow lifts and compacted to at least 98 percent of Standard Proctor Maximum Dry Density (SPMDD).

To provide effective surface drainage and prevent subgrade softening, the subgrade should be free of depressions and sloped preferably at a minimum grade of two percent toward the perimeter drainage system or under floor drainage system.

4.3 Drainage

Grain size analysis was carried out on selected soil samples at specified locations (as explained earlier and presented in **Appendix B**, Figures B1. The results were compared to the grain size curves for hydraulic conductivity estimates published by Ministry of the Environment (MOE) (Manual of Policy, Procedures and Guidelines for Private Sewage Disposal Systems). Based on these criteria, the estimated coefficient of permeability (k) and percolation time of the on-site soils are presented in **Table 4.1**.

Based on visual observations and the grain size distribution shown in **Table 3.1** and the estimated percolation time presented in **Table 4.1**, the native soils generally encountered in the boreholes are not considered as free draining materials. Therefore, it is prudent that a drainage system be placed in proposed upgradation on existing sport fields area. To intercept the surface water potentially coming from adjacent grounds, it is recommended to construct a perimeter drainage system around the sport fields area or at least placement of interceptor drainage pipes along the perimeter of the proposed sport fields where the adjacent ground is at the same level or higher than the surface.



Table 4.1 Estimated Coefficient of Permeability & Percolation Time

Sample No.	Depth (m)	Soil Description	Coefficient of Permeability, k (cm/sec)	Percolation Time, T (mins/cm)	Note
BH1-SS3	1.5-2.1	Native silty sand till	4.1×10^{-4}	12-50	Medium to low permeability
BH7-SS5	3.1-3.7	Native silty sand till	5.0×10^{-4}	12-50	Medium to low permeability
BH6-SS2	0.6-1.2	Native: silty sand till	2.0×10^{-3}	8 - 20	Medium permeability
BH6-SS3	1.5-2.1	Native: silty sand till	1.8×10^{-4}	12-50	Medium to low permeability

The perimeter drainage system should extend below the granular base of the proposed sport fields area to intercept the surficial water from entering into the granular base. Assuming that satisfactory crossfalls in the order of two percent (2%) are provided on the subgrade toward the perimeter drainage system, the trapped water into the granular base material can be satisfactory drained by the perimeter drainage. However, in view of the wide surface area of the sport fields area and possibility of inadequate crossfalls, placement of underfloor drainage system in addition to perimeter drainage is recommended for the sport fields area structure. This ensures that no water will be trapped into the granular base and will be drained shortly after precipitations. The underfloor drain invert should be at least 100mm below the underside of granular base. Drainage tile should be placed in parallel rows, approximately 8m centre one way. A typical underfloor drainage scheme (if required) is shown on **Drawing 24**.

The drainage system (perimeter or underfloor) will include a 100mm (4") diameter weeping tile seated on 100mm thick layer of 20mm (3/4") clear stone with 150mm clear stone on top and sides. To prevent the migration of soil fine particles into the drainage system, the clear stone and weeping tiles should be wrapped in an approved filter membrane (Terrafix 360R or equivalent). The collected water should be led into a positive outlet or a sump outside the sport fields area.



4.4 Pavements

The recommended pavement structure for the track around the proposed playground area is presented on the following **Table 4.2**. The thickness of granular base and sub-base indicated on **Table 4.2** (excluding Asphaltic concrete) is also recommended under the proposed playground area.

The subgrade must be compacted to 98% SPMDD for at least the upper 300 mm unless accepted by Orbit Engineering Limited.

Table 4.2: Recommended Pavement Structure Thickness

Pavement Layer	Compaction Requirements	Minimum Thicknesses
Asphaltic Concrete	92.0 to 96.5% Maximum Relative Density	65 mm OPSS HL3F Wearing Course
Imported OPSS Granular A Base (or 20mm Crushed Limestone) with less than 5% fines	100% SPMDD*	100 mm
Selected Salvaged Existing Granular Base (only if free draining i.e. with less than 5% fines)	100% SPMDD	200 mm**

* Denotes Standard Proctor Maximum Dry Density, ASTM-D698

** The existing granular base materials contain 19% fines

4.5 Foundation

Foundations for building structures and light poles or similar structures in the sport fields area can be supported on conventional spread footings or short drilled piers placed on the undisturbed native soils at minimum depth of 1m from the existing grades at borehole locations for a geotechnical reaction of 150 kPa at the Serviceability Limit States (SLS) and a factored geotechnical resistance of 225 kPa at the Ultimate Limit State (ULS).

Higher bearing capacities could be available at deeper depths, if required.

Foundations designed to the specified bearing capacity at the SLS are expected to settle less than 25mm total and 19mm differential.



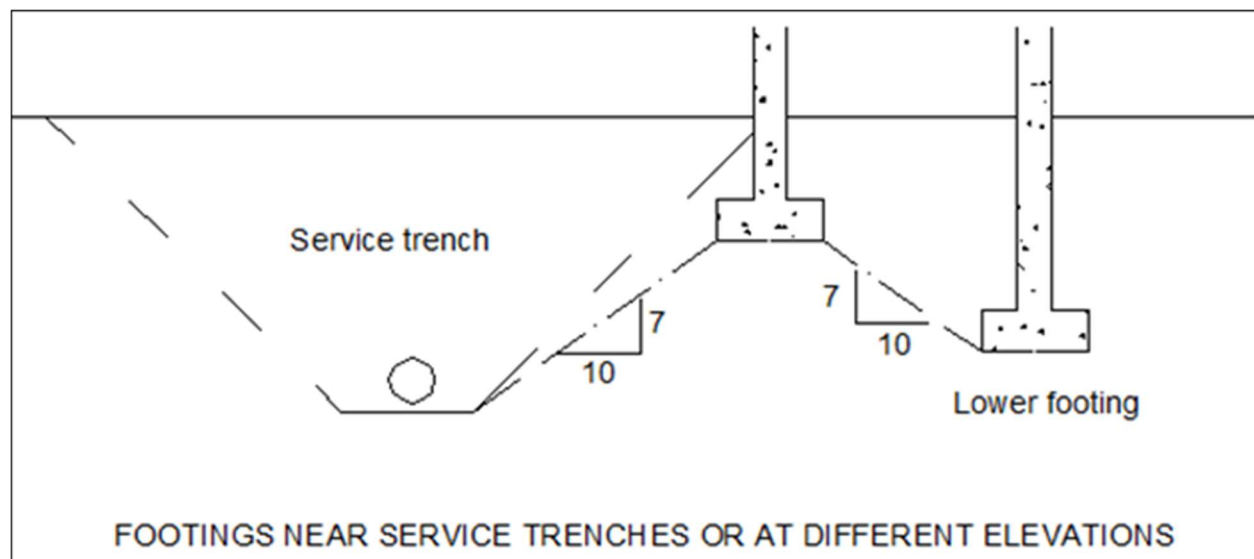
Based on the subsurface soil, temporary liners may be required to control caving (if encountered) and to facilitate inspection. Field inspection and confirmation of bearing stratum will be required during construction.

Note that the fill may contain obstruction such as wood, large concrete pieces etc. Provisions must be made in the contract for the removal of possible obstructions in the fill during the construction.

Excavation and installation of pole must conform to all applicable sections of the Occupational Health and Safety Act.

All foundations in exterior and unheated areas must be provided with a minimum of 1.2 metres of earth cover for frost protection or alternative equivalent insulation.

Where it is necessary to place footings at different levels, the upper footing must be founded below an imaginary 10 horizontal to 7 vertical line drawn up from the base of the lower footing. The lower footing must be installed first to help minimize the risk of undermining the upper footing. Should any excavation extend below the existing footing within the influence zone of imaginary 10 horizontal to 7 vertical line from the base of the existing footing, underpinning will be required. Footings close to underground services should also be set back from the services based on this slope limitation as shown on the following figure.



The recommended bearing capacities and the corresponding founding elevations would need to be confirmed by the representative of Orbit during construction. It should be noted that the recommended bearing capacities have been calculated by Orbit from the borehole information for the design stage only. The investigation and comments are necessarily on-going as new information of the underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes when foundation construction is underway. The interpretation between



boreholes and the recommendations of this report must therefore be checked through field inspections provided by Orbit to validate the information for use during the construction stage.

4.6 Floor Slab and Drainage

The floor slab without basement can also be supported on grade provided the existing fill and surficial weak/softened native soil are removed and the base thoroughly proof rolled. Any soft or unstable areas detected are further sub-excavated and replaced with imported Granular A and/or Granular B Type 2. The imported granular material must meet the specifications defined in OPSS-1010-13. The existing fill free from topsoil and organics may be used to raise the grade, provided it should be confirmed by a qualified geotechnical professional from Orbit at the time construction. The fill required to raise the grade must be placed in shallow lifts (each lift not more than 200mm) and compacted to at least 98 percent of Standard Proctor Maximum Dry Density (SPMDD).

A moisture barrier consisting of at least 200mm thick layer of well compacted 19mm clear crushed stone is recommended to place directly under the floor slab. The stone bed would act as a barrier and prevent capillary rise of moisture from the subgrade to the floor slab. This moisture barrier has been proven to be effective for conventional floor surfaces such as carpet, vinyl tile and ceramic tile. However, if special floor coverings such as sheet P.V.C. with heat sealed seams, as is used in gymnasiums, is considered, either a high efficiency vapour barrier or venting may be required to prevent moisture accumulating between the concrete floor and the P.V.C. flooring.

The estimated modulus of subgrade reaction (k_s) equal to 30MN/m^3 may be used for the design of slab-on-grade supported on native soils, provided that the construction is in accordance with the recommendations provided herein. If the engineered fill (Granular A or B Type II) having minimum thickness of 300mm, this value can be increased to 35MN/m^3 . The estimated value provided above may need to be adjusted based on the structure size and locations of detail design.

The floor slabs should not be tied to any load-bearing walls or columns unless they have been designed accordingly. Contraction/expansion joints should be provided for the slabs as required by the structural engineer.

If the floor slab is more than about 200 mm higher than the exterior grade, then perimeter drainage is not considered to be necessary. If the floor is lower, then use of a perimeter drainage system (**Drawing 25**) is recommended.

Frost Slab or adequate thermal insulation is required for any exterior slab which is sensitive to movement (e.g., sidewalk in front of the doors). The remaining portion of the exterior slab which is not sensitive to movement (e.g., regular sidewalks) does not require thermal insulation subject to placement of adequate granular base (min 200mm to 300mm thick), and positive drainage of the granular base. Differential frost heave should be expected where frost slab (or slab with thermal insulation) about the slab without any thermal insulation (e.g. away from the doors) or asphalt.



4.7 Earth Pressure

The lateral earth pressures acting on retaining walls or underground structures may be calculated from the following expression:

$$p = K(\gamma h + q)$$

Where p = Lateral earth pressure in kPa acting at depth h

K = Earth pressure coefficient equal to 0.5 for vertical walls and horizontal Granular B backfill used for permanent construction. Water pressure must be considered if continuous wall drains are not used.

γ = Unit weight of backfill, a value of 20.5 kN/m³ may be assumed

h = Depth to point of interest in meters

q = Equivalent value of surcharge on the ground surface in kPa

The above expression assumes that the perimeter drainage system prevents the buildup of any hydrostatic pressure behind the wall.

4.8 Earthquake Design parameters

Based on the borehole information and according to Table 4.1.8.4.A of OBC 2012, the subject site for the proposed upgradations can be classified as Class 'D' for seismic site response. Accordingly, the foundation factors F_a can be obtained from Table 4.1.8.4.B and F_v from Table 4.1.8.4.C for the design of the proposed structure. Consideration may be given to conduct an earthquake site assessment with the use of in-situ testing of the seismic characteristics (i.e., Geophysical testing) which may lead to an improved site classification, if required.



4.9 Environmental Considerations

As part of the geotechnical investigation, Orbit selected twenty-three (23) soil samples for chemical analysis. The purpose of the chemical analysis is to identify potential disposal or re-use onsite options for excess soil generated during construction. The soil samples were examined in the field for lithology as well as for aesthetic evidence of impacts (i.e., debris, staining and odours). In accordance with MECP sampling protocols, soil samples for potential chemical analysis were placed directly into laboratory supplied containers.

Chemical analyses were conducted by Eurofins Laboratories of Ottawa, Ontario. Eurofins is a member of the Canadian Association for Laboratory Accreditation Inc. (CALA) and meets the requirements of Section 47 of Ontario Regulation 153/04 (O. Reg. 153/04) certifying that the analytical laboratory be accredited in accordance with the International Standard ISO/IEC 17025 and with standards developed by the Standards Council of Canada.

No unusual stains or odours (odors) were observed in the soil samples screened as part of this geotechnical investigation. The soil submitted for environmental chemical analysis are described and summarized in **Table 4.3**. The results of the chemical analyses are presented on the Certificate of Analysis in Appendix C to this report.

Table 4.3 : Sample Locations and Performed Chemical Tests

Sample ID	Depth Below the Existing Grade (m)	Parameter Tested
BH1 – SS2	0.8– 1.4	PHC F1-F4, PAH _s , M+I
BH1 – SS5	3.1 – 3.7	BTEX
BH4 – SS2	0.8 – 1.4	PHC F1-F4, M+I
BH4 – SS3	1.5–2.1	BTEX
BH5 – SS2	0.8– 1.4	PHC F1-F4
BH5– SS3	1.5–2.1	BTEX
BH6 – SS2	0.8– 1.4	PHC F1-F4, M+I
BH6 – SS3	1.5–2.1	BTEX
BH7 - SS2	0.8– 1.4	PAH _s , M+I
BH7 – SS5	3.1 – 3.7	PHC F1-F4, M+I
BH9 - SS2	0.8 – 1.4	M+I



Sample ID	Depth Below the Existing Grade (m)	Parameter Tested
BH9 – SS3	1.5–2.1	BTEX
BH10- SS2	0.8 – 1.4	PHC F1-F4
BH10 – SS3	1.5–2.1	BTEX
BH11 – SS3	1.5–2.1	M+I
BH13 – SS2	0.8 – 1.4	PAH _s
BH13 – SS5	3.1 – 3.7	PHC F1-F4, M+I
BH14 - SS2	0.8 – 1.4	PAH _s , M+I
BH14 – SS3	1.5–2.1	BTEX
BH15 – SS2	0.8 – 1.4	PAH _s
BH16 – SS2	0.8 – 1.4	M+I
BH16 – SS3	1.5–2.1	PAH _s
BH21 – SS2	0.8 – 1.4	PHC F1-F4, PAH _s , M+I
BH21 – SS4	2.3 – 2.9	BTEX, M+I
BH22 – SS2	0.8 – 1.4	PHC F1-F4, M+I

4.9.1 Soil Chemical Test Results

The results of the chemical analyses for soil were compared to MOECC Table 1 Full Depth Background Site Condition Standards for Residential/Parkland/Institutional/Industrial/Commercial/Community (RPI/ICC) Property Use. The results indicate that the soil samples as outlined in Table 4.3 meet the Table 1 Standards for RPI/ICC property use except SAR; therefore, they also meet MOECC Table 2 and Table 3 Residential Parkland Institutional (RPI) and Industrial Commercial Community (ICC).



4.10 Corrosivity Test Evaluation

Three (3) selected soil sample from fill and native deposit was submitted for corrosivity analysis to assess the aggressiveness of soil. The test results for pH and water-soluble sulphate content in native soil are presented in **Appendix C** and are also shown on **Table 4.4:**

Table 4.4: Sulphate and PH Test Results of Soil Samples

Sample No.	Depth (m)	Soil Type	pH	Water Soluble Sulphate Content (%)
BH1 – SS1	0.4 – 0.6	Fill: Sandy Silt	7.85	<0.04
BH7 – SS1	0.3 – 0.6	Fill: Sandy silt	8.02	0.04
BH13 – SS3	1.5 -2.1	Native: Sandy silt	8.60	<0.04

According to Table 3 of CSA Standard, CAN/CSA-A23.1-04 the degree of exposure to sulphate attack is negligible at the selected soil samples, therefore normal Portland cement (GU) can be used in the subsurface concrete.

The need for cathodic protection to grey or ductile cast iron pipe as given in the AWWA C105/A21.5-10, Table A1 “Soil-test evaluation”. A summary of the evaluation based on the test values is presented in **Table 4.5.**

Table 4.5: Summary of Test Results for Cathodic Protection

Sample No.	Depth (m)	Soil Type	Assigned Points
BH1 – SS1	0.4 – 0.6	Fill: Sandy Silt	3
BH7 – SS1	0.3 – 0.6	Fill: Sandy silt	5
BH13 – SS3	1.5 -2.1	Native: Sandy silt	3

According to the AWWA rating system, at locations where assigned point is less than 10, cathodic protection is not required.



4.10.1 Conclusion and Recommendations

On the basis of limited chemical testing to-date, the on-site soil materials are free from potential environmental impacts and meet the soil quality parameters for re-use on site minimum at 1.5m below existing grade or for disposal at RPI and ICC sites permitted to accept fill. It should be noted that acceptance of this material will be at the discretion of the receiving site(s). Additional testing may be required. The re-use of on-site materials are still subject to geotechnical consideration.

If disposed at a licensed landfill, additional chemical testing may be required to classify the material for waste disposal purposes in accordance with Ontario Regulation 347 (as amended by O.Reg.558/00). It should be noted that acceptance of this material will be at the discretion of the receiving site(s).

These environmental considerations do not address the possible suitability of the soil for use as engineered fill. The reuse of any soil on site is subject to geotechnical considerations.

In addition, if soil suspected to contain unusual stains or odours (e.g. hydrocarbon or solvent odours), or contains rubble, debris, cinders or other visual evidence of impact is encountered during the excavation operations, Orbit should be contacted so that additional soil samples can be obtained for chemical testing. Any suspected impacted soil should not be removed from the site until the test results have been reviewed.

This testing has been conducted in order to assess possible options for soil disposal only and is not intended to constitute a Phase Two Environmental Site Assessment and as such does not comment on the environmental condition of the site. Soil quality may vary at locations other than those tested. Furthermore, the testing conducted as part of this program will not substantiate the preparation of a Record of Site Condition in accordance with the MOECC Standards. Should a Record of Site Condition be required, a Phase Two Environmental Site Assessment must be conducted, at a minimum, with the possible need for additional subsurface investigations.

4.11 Overall Design Review, Material Testing, and Inspection

We recommend that Orbit is permitted to review all final services, sport fields area designs and related specifications prior to construction to ensure that they are consistent with the recommendations of this report. It is also suggested that Orbit be afforded the opportunity to carry out field inspection and material testing during construction to ensure that the construction procedures comply with the design recommendations.



5 GENERAL COMMENTS

The recommended bearing capacities and the corresponding founding elevations would need to be confirmed by the representative of Orbit during construction. It should be noted that the recommended bearing capacities have been calculated by Orbit from the borehole information for the design stage only. The investigation and comments are necessarily on-going as new information of the underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes when foundation construction is underway. The interpretation between boreholes and the recommendations of this report must therefore be checked through field inspections provided by Orbit to validate the information for use during the construction.

In this regard, Orbit should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, Orbit will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.



6 CLOSURE

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

For and Behalf of Orbit Engineering Limited

Apr 18, 2024 Apr 18, 2024

Dr. Aly Ahmed, Ph.D., P.Eng., QP_{ESA}
Principal Geotechnical Engineer

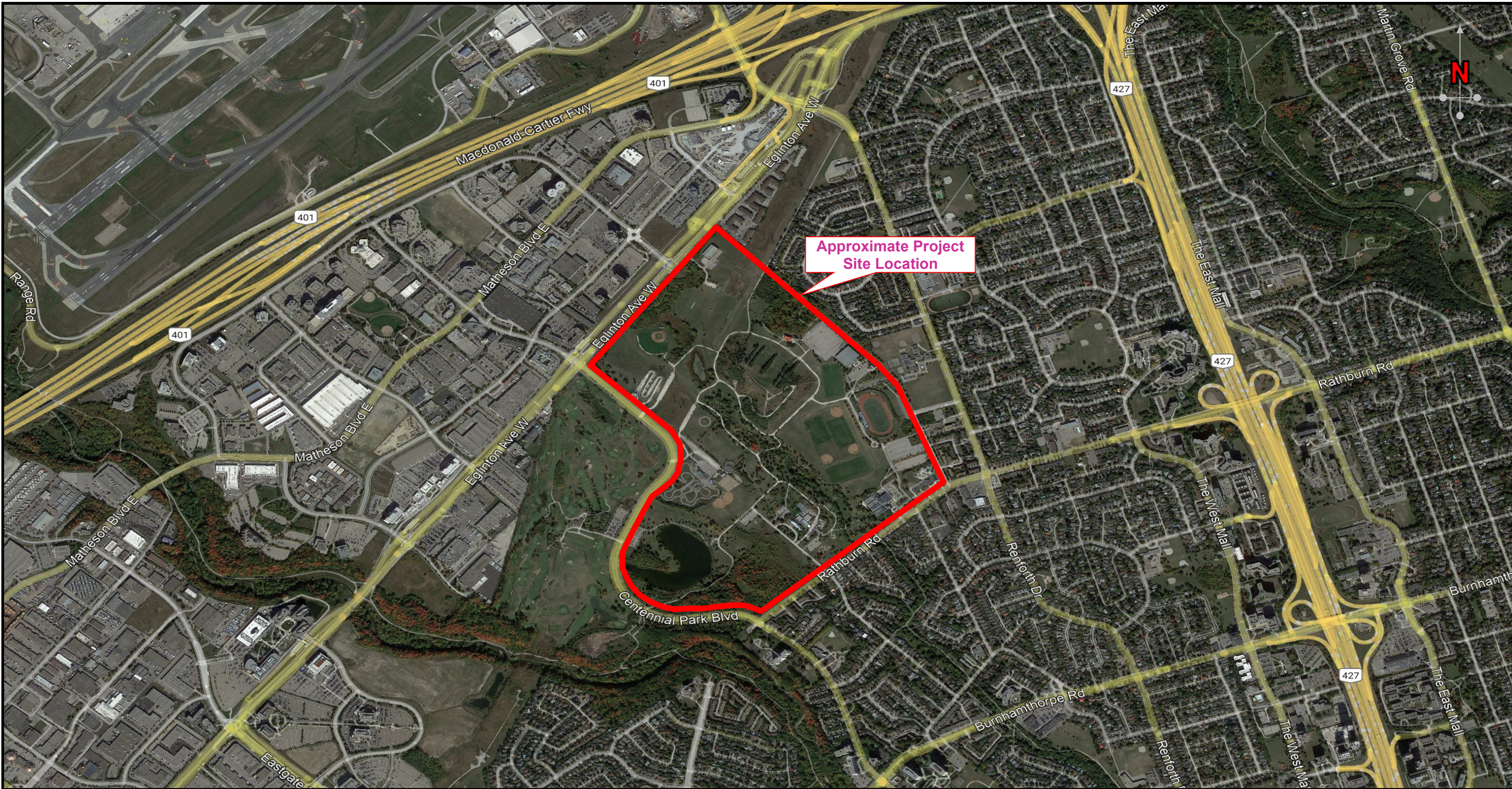



Reviewed By:

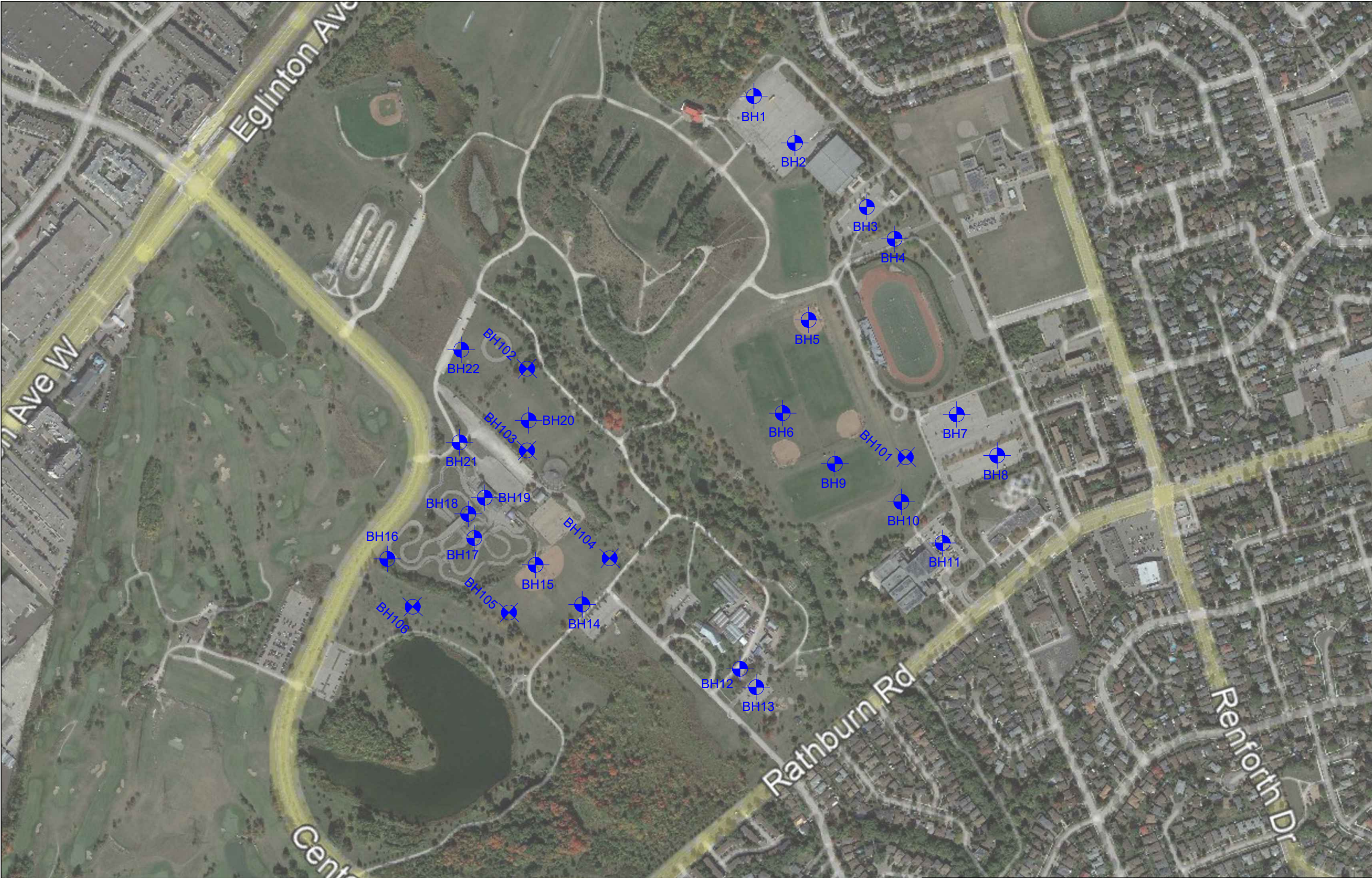
Hafiz Muneeb Ahmad, M.Eng. M.Sc., M. Eng., P.Eng., QP_{ESA}
Senior Principal Engineer





Drawings

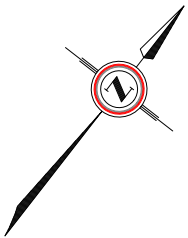


APPROXIMATE SITE LOCATION PLAN			
	Date: JUL 2023		Prepared By: Z. A
	Project: OE231465GG		Reviewed By: H. A
	Prepared for: CITY OF TORONTO		Drawing No. 1



- NOTES:
1. The boundaries and soil types have been established only at borehole locations. Between boreholes they are assumed and may be subject to considerable error.
 2. Soil samples will be retained in storage for three months and then destroyed unless the client advises an extended time period is required.
 3. Granular base fill quantities should not be established from the information provided at the borehole locations.
 4. Borehole elevations should not be used to design building(s) or floor slab(s) or parking lot(s) grades.
 5. This drawing forms part of the report (project number as referenced) and should only be used in conjunction with this report.

- LEGENDS
-  **Approximate Borehole Location BH 1- 22 (Drilled in April 2023)**
 -  **Approximate Borehole Location BH 101- 106 (Drilled in Jan 2024)**



Drawn	S. M.
Approved	H. A.
Date	APRIL 2024
Scale	AS SHOWN
Original size	TABLOID



ORBITENGINEERING
Consulting Engineers

Client: CITY OF TORONTO PARKS AND FORESTRY AND RECREATION	
Project: GEOTECHNICAL INVESTIGATION CENTENNIAL PARK - PROPOSED RECREATIONAL DEVELOPMENT 256 CENTENNIAL PARK RD, ETOBICOKE, ON	
Title: APPROXIMATE BOREHOLE LOCATION PLAN	
Project no: OE231465GG	Drawing no: 1A

DRAWING 1B: NOTES ON SAMPLE DESCRIPTIONS

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Society for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by Orbit Engineering Limited also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION											
CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		
<div><div></div><div>0.002</div><div>0.006</div><div>0.02</div><div>0.06</div><div>0.2</div><div>0.6</div><div>2.0</div><div>6.0</div><div>20</div><div>60</div><div>200</div></div>											
EQUIVALENT GRAIN DIAMETER IN MILLIMETRES											
CLAY (PLASTIC) TO SILT (NONPLASTIC)				FINE SAND		CRS. SAND	FINE GRAVEL		COARSE GRAVEL		
UNIFIED SOIL CLASSIFICATION											

2. **Fill:** Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc.; none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advice of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.
3. **Till:** The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

PROJECT: Final Geotechnical Investigation for Centennial Park
 CLIENT: City of Toronto Parks, Forestry and Recreation
 PROJECT LOCATION: Centennial Park, Toronto, ON
 DATUM:
 BH LOCATION: Refer to Borehole Location Plan (Drawing 1A)

DRILLING DATA
 Method: Solid Stem Auger
 Diameter: 200mm
 Date: Jan-11-2024
 REF. NO.: OE231465GG
 DRAWING NO.: A1

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (C _u) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)											WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE													
0.0	Topsoil: 200mm																				
0.2	Fill: sandy silt, trace topsoil and rootlets, brown, moist, loose to compact		1	SS	8																
0.8	Sandy Silt Till: some clay, trace gravel, greyish brown, moist, compact to dense		2	SS	26																
			3	SS	29																
			4	SS	35																
			5	SS50/25mm																	
	grey and very dense below 3.5m																				
4.9	Shale: highly weathered, grey, moist, hard		6	SS50/125mm																	
5.2	End of Borehole Note: Water Levels: (i) During Drilling: Dry (ii) At Completion: Dry																				

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3 , × 3 : Numbers refer to Sensitivity

○ = 3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park
CLIENT: City of Toronto Parks, Forestry and Recreation
PROJECT LOCATION: Centennial Park, Toronto, ON
DATUM:
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A)

DRILLING DATA
Method: Solid Stem Auger
Diameter: 200mm
Date: Jan-11-2024

REF. NO.: OE231465GG
DRAWING NO.: A2

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



GROUNDWATER ELEVATIONS

	1st	2nd	3rd	4th
Measurement				

GRAPH
NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ $\epsilon = 3\%$ Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park							DRILLING DATA											
CLIENT: City of Toronto Parks, Forestry and Recreation							Method: Solid Stem Auger											
PROJECT LOCATION: Centennial Park, Toronto, ON							Diameter: 200mm											
DATUM:							Date: Jan-11-2024											
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A)							REF. NO.: OE231465GG											
							DRAWING NO.: A3											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)					W _p W W _L					
								20 40 60 80 100					20 40 60 80 100					
0.0	Topsoil: 200mm																	
0.2	Fill: sandy silt, trace clay, gravel and rootlets, dark brown, moist, compact		1	SS	12													
0.9	Sandy Silt Till: some clay, trace gravel, brown, moist, compact to dense		2	SS	36													
			3	SS	35													
	grey and very dense below 2.4m		4	SS	56													
2.7	Shale: highly weathered, grey, moist, hard																	
			5	SS50/76mm														
3.3	End of Borehole Note: Water Levels: (i) During Drilling: Dry (ii) At Completion: Dry																	

PROJECT: Final Geotechnical Investigation for Centennial Park				DRILLING DATA												
CLIENT: City of Toronto Parks, Forestry and Recreation				Method: Solid Stem Auger												
PROJECT LOCATION: Centennial Park, Toronto, ON				Diameter: 200mm												
DATUM:				Date: Jan-11-2024												
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A)				REF. NO.: OE231465GG												
				DRAWING NO.: A4												
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			POCKET PEN. (Cu) (kPa)		NATURAL UNIT WT (kN/m³)		REMARKS AND GRAIN SIZE DISTRIBUTION (%)	
(m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	SHEAR STRENGTH (kPa)		WATER CONTENT (%)						
								20 40 60 80 100	○ UNCONFINED + FIELD VANE & Sensitivity	Wp	W	WL				
								20 40 60 80 100	● QUICK TRIAXIAL x LAB VANE							
0.0	Topsoil: 200mm									10	20	30			GR SA SI CL	
0.2	Fill: sandy silt, trace clay, gravel and rootlets, brown, moist, loose to compact		1	SS	9											
			2	SS	26											
			3	SS	29											
			4	SS	35											
			5	SS	49											

PROJECT: Final Geotechnical Investigation for Centennial Park
 CLIENT: City of Toronto Parks, Forestry and Recreation
 PROJECT LOCATION: Centennial Park, Toronto, ON
 DATUM:
 BH LOCATION: Refer to Borehole Location Plan (Drawing 1A)

DRILLING DATA
 Method: Solid Stem Auger
 Diameter: 200mm
 Date: Jan-11-2024
 REF. NO.: OE231465GG
 DRAWING NO.: A5

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (C _u) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)											WATER CONTENT (%)		
								○ UNCONFINED	● QUICK TRIAXIAL	+	×	FIELD VANE & Sensitivity							LAB VANE		
0.0	Topsoil: 200mm																				
0.2	Fill: sandy silt, trace clay, gravel and rootlets, brown, moist, loose to compact		1	SS	9																
1.1	Sandy Silt Till: some clay, trace gravel, brown, moist, compact to dense		2	SS	24																
			3	SS	49																
	grey and very dense below 2.3m		4	SS	57																
			5	SS55/150mm																	
3.4	Shale: highly weathered, grey, moist, hard																				
			6	SS50/55mm																	
4.9	End of Borehole Note: Water Levels: (i) During Drilling: Dry (ii) At Completion: Dry																				

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3 , × 3 : Numbers refer to Sensitivity

○ = 3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park
 CLIENT: City of Toronto Parks, Forestry and Recreation
 PROJECT LOCATION: Centennial Park, Toronto, ON
 DATUM:
 BH LOCATION: Refer to Borehole Location Plan (Drawing 1A)

DRILLING DATA
 Method: Solid Stem Auger
 Diameter: 200mm
 Date: Jan-11-2024
 REF. NO.: OE231465GG
 DRAWING NO.: A6

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)					W _P W W _L					GR SA SI CL			
								○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)								
0.0	Topsoil: 200mm							20	40	60	80	100									
0.2	Fill: sandy silt, trace clay, gravel and rootlests, brown, moist, loose to compact		1	SS	8																
			2	SS	6																
1.7	Sandy Silt Till: some clay, trace gravel, dark brown, moist, compact to dense		3	SS	12																
			4	SS	15																
	grey and dense below 3.0m		5	SS	51																
4.6	Shale: highly weathered, grey, moist, hard		6	SS50/50mm																	
4.9	End of Borehole Note: Water Levels: (i) During Drilling: Dry (ii) At Completion: Dry																				

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3 , × 3 : Numbers refer to Sensitivity

○ = 3% Strain at Failure

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity $\bigcirc^8 = 3\%$ Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park				DRILLING DATA													
CLIENT: City of Toronto Parks, Forestry and Recreation				Method: Portable Drilling Equipment													
PROJECT LOCATION: Centennial Park, Toronto, ON				Diameter: 50mm													
DATUM:				Date: Apr-11-2023													
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834695.22 E 613977.2				PROJECT NO.: OE231465GG													
				DRAWING NO.: 3													
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		POCKET PEN. (Cu) (kPa)		NATURAL UNIT WT (kNm ³)		REMARKS AND GRAIN SIZE DISTRIBUTION (%)	
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m												
0.0	Asphalt: 100mm																
0.1	Granular base: 300mm																
0.4	Fill: sandy silt, trace gravel, greyish brown, very moist, compact		1	SS	14												
0.8	Silty Sand Till: some clay, greyish brown, moist, compact		2	SS	25												
1																	
			3	SS	23												
2			4	SS	27												
2.4	End of Borehole Note: Water Levels: (i) During Drilling: -- (ii) At Completion: --																

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, x 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park							DRILLING DATA							
CLIENT: City of Toronto Parks, Forestry and Recreation							Method: Portable Drilling Equipment							
PROJECT LOCATION: Centennial Park, Toronto, ON							Diameter: 50mm							
DATUM:							Date: Apr-12-2023							
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834589.34 E 614094.62							PROJECT NO.: OE231465GG							
							DRAWING NO.: 4							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)		W _p W W _L				
0.0	Asphalt: 80mm													
0.1	Granular base: 120mm													
0.2	Fill: sandy silt, trace gravel, greyish brown, very moist, compact		1	SS	10									
0.8	Silty Sand Till: some clay, greyish brown, moist, compact		2	SS	16									
			3	SS	23									
			4	SS	27									
2.4	End of Borehole Note: Water Levels: (i) During Drilling: -- (ii) At Completion: --													

GROUNDWATER ELEVATIONS

1st 2nd 3rd 4th
Measurement

GRAPH
NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park								DRILLING DATA							
CLIENT: City of Toronto Parks, Forestry and Recreation								Method: Portable Drilling Equipment							
PROJECT LOCATION: Centennial Park, Toronto, ON								Diameter: 50mm				PROJECT NO.: OE231465GG			
DATUM:								Date: Apr-03-2023				DRAWING NO.: 5			
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834558.97 E 614128															
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)		WATER CONTENT (%)					
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE & Sensitivity × LAB VANE	W _p	W	W _L			
0.0	Topsoil: 300mm														
0.3	Fill: sandy silt, trace topsoil and rootlets, brown, moist, compact		1	SS	14										
0.8	Silty Sand Till: some clay, greyish brown, moist, compact		2	SS	19										
			3	SS	21										
			4	SS	23										
2.4	End of Borehole Note: Water Levels: (i) During Drilling: -- (ii) At Completion: --														



GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park				DRILLING DATA													
CLIENT: City of Toronto Parks, Forestry and Recreation				Method: Portable Drilling Equipment													
PROJECT LOCATION: Centennial Park, Toronto, ON				Diameter: 50mm													
DATUM:				Date: Apr-03-2023													
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834401.69 E 613989.47				PROJECT NO.: OE231465GG													
				DRAWING NO.: 6													
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		POCKET PEN. (Cu) (kPa)		NATURAL UNIT WT (kNm ³)		REMARKS AND GRAIN SIZE DISTRIBUTION (%)	
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m				20 40 60 80 100	W _p	W	W _L				GR SA SI CL	
0.0	Fill: sandy silt, some clay, trace gravel, brown, moist, loose		1	SS	9												
0.4	Silty Sand Till: some clay, greyish brown, moist, compact		2	SS	15												
			3	SS	18												
			4	SS	22												
2.4	End of Borehole Note: Water Levels: (i) During Drilling: -- (ii) At Completion: --																

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, x 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park				DRILLING DATA													
CLIENT: City of Toronto Parks, Forestry and Recreation				Method: Portable Drilling Equipment													
PROJECT LOCATION: Centennial Park, Toronto, ON				Diameter: 50mm													
DATUM:				Date: Apr-03-2023													
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834238.93 E 613981.19				PROJECT NO.: OE231465GG													
				DRAWING NO.: 7													
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		POCKET PEN. (Cu) (kPa)		NATURAL UNIT WT (kNm ³)		REMARKS AND GRAIN SIZE DISTRIBUTION (%)	
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m				20 40 60 80 100	W _p	W	W _L				GR SA SI CL	
0.0	Topsoil: 200mm																
0.2	Fill: sandy silt, trace topsoil and rootlets, brown, moist, compact		1	SS	16												
0.8	Silty Sand Till: some clay, greyish brown, moist, compact		2	SS	21												
			3	SS	25												
			4	SS	27												
2.4	End of Borehole Note: Water Levels: (i) During Drilling: -- (ii) At Completion: --																

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park

CLIENT: City of Toronto Parks, Forestry and Recreation

PROJECT LOCATION: Centennial Park, Toronto, ON

DATUM:

BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834244.68 E 614205.78

DRILLING DATA

Method: Solid Stem Auger

Diameter: 150mm

Date: Apr-12-2023

PROJECT NO.: OE231465GG

DRAWING NO.: 8

[illegible]

GROUNDWATER ELEVATIONS

Measurement

1st 2nd 3rd 4th

GRAPH
NOTES

$+^3, \times^3$: Numbers refer to Sensitivity

○ **$\epsilon_f = 3\%$** Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park							DRILLING DATA								
CLIENT: City of Toronto Parks, Forestry and Recreation							Method: Portable Drilling Equipment								
PROJECT LOCATION: Centennial Park, Toronto, ON							Diameter: 50mm				PROJECT NO.: OE231465GG				
DATUM:							Date: Apr-03-2023				DRAWING NO.: 9				
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834203.26 E 614309.67															
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kNm ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20 40 60 80 100	W _p	W	W _L	WATER CONTENT (%)			
								SHEAR STRENGTH (kPa)							
							○ UNCONFINED + FIELD VANE & Sensitivity								
							● QUICK TRIAXIAL × LAB VANE								
0.0	Asphalt: 75mm														
0.1	Granular base: 200mm														
0.3	Fill: sandy silt, trace gravel, brown, moist, compact		1	SS	11										
0.6	Silty Sand Till: some clay, greyish brown, moist, compact		2	SS	18										
			3	SS	22										
			4	SS	28										
2.4	End of Borehole Note: Water Levels: (i) During Drilling: -- (ii) At Completion: --														




GROUNDWATER ELEVATIONS

1st 2nd 3rd 4th
Measurement

GRAPH
NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park				DRILLING DATA													
CLIENT: City of Toronto Parks, Forestry and Recreation				Method: Portable Drilling Equipment													
PROJECT LOCATION: Centennial Park, Toronto, ON				Diameter: 50mm													
DATUM:				Date: Apr-03-2023													
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834173.3 E 614008.38				PROJECT NO.: OE231465GG													
				DRAWING NO.: 10													
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		POCKET PEN. (Cu) (kPa)		NATURAL UNIT WT (kN/m ³)		REMARKS AND GRAIN SIZE DISTRIBUTION (%)	
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m												
0.0	Topsoil: 200mm																
0.2	Fill: sandy silt, trace topsoil and rootlets, brown, moist, compact		1	SS	13												
0.8	Silty Sand Till: some clay, greyish brown, moist, compact		2	SS	21												
			3	SS	25												
			4	SS	29												
2.4	End of Borehole Note: (i) During Drilling: -- (ii) At Completion: --																






GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, x 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park							DRILLING DATA									
CLIENT: City of Toronto Parks, Forestry and Recreation							Method: Portable Drilling Equipment									
PROJECT LOCATION: Centennial Park, Toronto, ON							Diameter: 50mm				PROJECT NO.: OE231465GG					
DATUM:							Date: Apr-06-2023				DRAWING NO.: 11					
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834105.96 E 614112.6																
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (C _u) (kPa)	NATURAL UNIT WT (kNm ⁻³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)			W _p W W _L					
								○ UNCONFINED ● QUICK TRIAXIAL	+	FIELD VANE & Sensitivity × LAB VANE	WATER CONTENT (%)					
0.0	Topsoil: 300mm															GR SA SI CL
0.3	Fill: sandy silt, trace topsoil and rootlets, brown, moist, compact		1	SS	9											
0.6	Silty Sand Till: some clay, brown, moist, compact		2	SS	20											
			3	SS	23											
			4	SS	27											
2.4	End of Borehole Note: Water Levels: (i) During Drilling: -- (ii) At Completion: --															





GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park							DRILLING DATA															
CLIENT: City of Toronto Parks, Forestry and Recreation							Method: Portable Drilling Equipment															
PROJECT LOCATION: Centennial Park, Toronto, ON							Diameter: 50mm															
DATUM:							Date: Apr-06-2023															
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834034.45 E 614220.29							PROJECT NO.: OE231465GG															
							DRAWING NO.: 12															
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (C _u) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)														
								20 40 60 80 100														
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)									
								20 40 60 80 100					10 20 30									
0.0	Asphalt: 80mm																					
0.1	Granular base: 120mm																					
0.2	Fill: sandy silt, trace gravel, greyish brown, very moist, compact		1	SS	10																	
0.7	Silty Sand Till: some clay, brown, moist, compact		2	SS	21																	
			3	SS	25																	
			4	SS	29																	
2.4	End of Borehole Note: Water Levels: (i) During Drilling: -- (ii) At Completion: --																					






GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park				DRILLING DATA													
CLIENT: City of Toronto Parks, Forestry and Recreation				Method: Portable Drilling Equipment													
PROJECT LOCATION: Centennial Park, Toronto, ON				Diameter: 50mm													
DATUM:				Date: Apr-06-2023													
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4833875.88 E 613875.09				PROJECT NO.: OE231465GG													
				DRAWING NO.: 13													
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		POCKET PEN. (Cu) (kPa)		NATURAL UNIT WT (kNm ³)		REMARKS AND GRAIN SIZE DISTRIBUTION (%)	
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m				20 40 60 80 100	W _p	W	W _L				GR SA SI CL	
0.0	Topsoil: 150mm																
0.2	Fill: sandy silt, trace topsoil and rootlets, brown, moist, compact		1	SS	10												
0.8	Silty Sand Till: some clay, brown, moist, compact		2	SS	18												
			3	SS	20												
			4	SS	24												
2.4	End of Borehole Note: Water Levels: (i) During Drilling: -- (ii) At Completion: --																

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park								DRILLING DATA									
CLIENT: City of Toronto Parks, Forestry and Recreation								Method: Solid Stem Auger									
PROJECT LOCATION: Centennial Park, Toronto, ON								Diameter: 150mm									
DATUM:								Date: Apr-12-2023									
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4833817.4 E 613914.14								PROJECT NO.: OE231465GG									
								DRAWING NO.: 14									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)				W _p W W _L					
								○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%)					
0.0	Asphalt: 100mm							20	40	60	80	100	10	20	30		
0.1	Granular base: 350mm																
0.4	Fill: sandy silt, trace gravel, greyish brown, moist, compact		1	SS	17								○				
1.0	Silty Sand Till: some clay, greyish brown, moist, dense to very dense		2	SS	30								○				
			3	SS	46								○				
			4	SS	61								○				
			5	SS	65								○				
			6	SS	70								○				
6.1	Shale(Assumed Bedrock Surface): highly weathered, grey, moist, hard		7	SS	50/150mm								○				
6.4	End of Borehole Note: Water Levels: (i) During Drilling: -- (ii) At Completion: --																






GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park							DRILLING DATA														
CLIENT: City of Toronto Parks, Forestry and Recreation							Method: Portable Drilling Equipment														
PROJECT LOCATION: Centennial Park, Toronto, ON							Diameter: 50mm				PROJECT NO.: OE231465GG										
DATUM:							Date: Apr-10-2023				DRAWING NO.: 15										
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4833955.24 E 613619.19																					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (C _u) (kPa)	NATURAL UNIT WT (kNm ⁻³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)											WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE													
0.0	Topsoil: 300mm																				
0.3	Fill: sandy silt, trace topsoil and rootlets, greyish brown, moist, compact		1	SS	13																
0.6	Silty Sand Till: some clay, grey, wet, compact		2	SS	13																
			3	SS	24																
			4	SS	27																
2.4	End of Borehole Note: Water Levels: (i) During Drilling: 0.9m (ii) At Completion: 2.4m																				


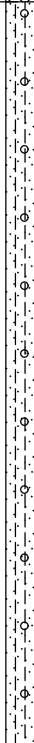
GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+³, ×³: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park								DRILLING DATA										
CLIENT: City of Toronto Parks, Forestry and Recreation								Method: Portable Drilling Equipment										
PROJECT LOCATION: Centennial Park, Toronto, ON								Diameter: 50mm				PROJECT NO.: OE231465GG						
DATUM:								Date: Apr-10-2023				DRAWING NO.: 16						
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4833995.44 E 613552.96																		
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)					WATER CONTENT (%)					
								○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE					W _p W W _L					
0.0	Fill: sandy silt, trace clay and gravel, brown, moist, compact		1	SS	11												GR SA SI CL	
0.4	Silty Sand Till: some clay, greyish brown, moist, compact		2	SS	14													
			3	SS	21													
			4	SS	25													
2.4	End of Borehole Note: Water Levels: (i) During Drilling: -- (ii) At Completion: --																	






GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

 +³, ×³: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park								DRILLING DATA										
CLIENT: City of Toronto Parks, Forestry and Recreation								Method: Portable Drilling Equipment										
PROJECT LOCATION: Centennial Park, Toronto, ON								Diameter: 50mm				PROJECT NO.: OE231465GG						
DATUM:								Date: Apr-10-2023				DRAWING NO.: 17						
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834032.12 E 613326.35																		
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)					W _p	W	W _L			
								○ UNCONFINED	+	FIELD VANE & Sensitivity	×	LAB VANE	WATER CONTENT (%)					
0.0	Topsoil: 200mm							20	40	60	80	100						GR SA SI CL
0.2	Fill: sandy silt, trace topsoil and rootlets, brown, moist, compact		1	SS	12													
0.6	Silty Sand Till: some clay, grey, moist, compact		2	SS	18													
			3	SS	23													
			4	SS	28													
2.4	End of Borehole Note: Water Levels: (i) During Drilling:-- (ii) At Completion:--																	

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park							DRILLING DATA									
CLIENT: City of Toronto Parks, Forestry and Recreation							Method: Portable Drilling Equipment									
PROJECT LOCATION: Centennial Park, Toronto, ON							Diameter: 50mm									
DATUM:							Date: Apr-10-2023									
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834048.69 E 613468.86							PROJECT NO.: OE231465GG									
							DRAWING NO.: 18									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)	
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)								WATER CONTENT (%)
								20	40							
							○ UNCONFINED + FIELD VANE & Sensitivity									
							● QUICK TRIAXIAL × LAB VANE									
							20 40 60 80 100				10 20 30				GR SA SI CL	
0.0	Asphalt: 75mm															
0.1	Granular base: 150mm															
0.2	Fill: sandy silt, trace clay and gravel, brown, moist, compact		1	SS	10											
0.8	Silty Sand Till: some clay, greyish brown, moist, compact		2	SS	38											
			3	SS	42											
			4	SS	56											
2.4	End of Borehole Note: Water Levels: (i) During Drilling:-- (ii) At Completion: --															






GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park				DRILLING DATA												
CLIENT: City of Toronto Parks, Forestry and Recreation				Method: Portable Drilling Equipment												
PROJECT LOCATION: Centennial Park, Toronto, ON				Diameter: 50mm												
DATUM:				Date: Apr-10-2023												
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834133.63 E 613440.4				PROJECT NO.: OE231465GG												
				DRAWING NO.: 19												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kNm ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			"N" BLOWS 0.3 m	SHEAR STRENGTH (kPa)				WATER CONTENT (%)				
0.0	Topsoil: 300mm															
0.3	Fill: sandy silt, trace topsoil and rootlets, brown, moist, compact		1	SS	10											
0.6	Silty Sand Till: some clay, greyish brown, moist, compact		2	SS	19											
			3	SS	21											
			4	SS	26											
2.4	End of Borehole Note: Water Levels: (i) During Drilling: -- (ii) At Completion: --															

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, x 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park							DRILLING DATA							
CLIENT: City of Toronto Parks, Forestry and Recreation							Method: Portable Drilling Equipment							
PROJECT LOCATION: Centennial Park, Toronto, ON							Diameter: 50mm				PROJECT NO.: OE231465GG			
DATUM:							Date: Apr-11-2023				DRAWING NO.: 20			
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834149.78 E 613504.2														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)		W _p W W _L				
0.0 0.1	Asphalt: 50mm Granular base: 150mm							20 40 60 80 100						
0.2	Fill: sandy silt, trace clay and gravel, brown, moist, compact		1	SS	11									
			2	SS	19									
1.0	Silty Sand Till: some clay, greyish brown, moist, compact		3	SS	17									
			4	SS	22									
2.4	End of Borehole Note: Water Levels: (i) During Drilling:-- (ii) At Completion: --													












GROUNDWATER ELEVATIONS





Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+³, ×³: Numbers refer to Sensitivity

○ s=3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park							DRILLING DATA																
CLIENT: City of Toronto Parks, Forestry and Recreation							Method: Portable Drilling Equipment																
PROJECT LOCATION: Centennial Park, Toronto, ON							Diameter: 50mm																
DATUM:							Date: Apr-11-2023																
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834255.14 E 613555.52							PROJECT NO.: OE231465GG																
							DRAWING NO.: 21																
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (C _u) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)					
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)											WATER CONTENT (%)				
								20	40	60	80	100							20	40	60	80	100
0.0	Topsoil: 150mm																	GR SA SI CL					
0.2	Fill: sandy silt, trace to topsoil and rootlets, trace gravel, brown, moist, compact		1	SS	11																		
0.8	Silty Sand Till: some clay, greyish brown, moist, compact		2	SS	19																		
																							
																							
																							
																							
																							
																							
																							
																							
2.4	End of Borehole Note: Water Levels: (i) During Drilling: -- (ii) At Completion: --																						

PROJECT: Final Geotechnical Investigation for Centennial Park						DRILLING DATA																	
CLIENT: City of Toronto Parks, Forestry and Recreation						Method: Solid Stem Auger																	
PROJECT LOCATION: Centennial Park, Toronto, ON						Diameter: 150mm																	
DATUM:						Date: Apr-11-2023																	
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834231.53 E 613463.87						PROJECT NO.: OE231465GG																	
						DRAWING NO.: 22																	
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (C _u) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)					
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)											WATER CONTENT (%)				
								20 40 60 80 100											20 40 60 80 100				
0.0	Granular base: 100mm																						
0.1	Fill: sandy silt, trace clay and gravel, grey, moist, compact		1	SS	13																		
0.4	Silty Sand Till: some clay, greyish brown, moist, compact																						
			2	SS	10																		
			3	SS	20																		
2.3	Shale: highly weathered upper 0.6m, grey		4	SS	50/150mm																		
			5	SS	100/125mm																		
3.2	End of Borehole Note: Water Levels: (i) During Drilling: -- (ii) At Completion: --																						






GROUNDWATER ELEVATIONS

1st 2nd 3rd 4th
Measurement

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ = 3% Strain at Failure

PROJECT: Final Geotechnical Investigation for Centennial Park				DRILLING DATA											
CLIENT: City of Toronto Parks, Forestry and Recreation				Method: Portable Drilling Equipment											
PROJECT LOCATION: Centennial Park, Toronto, ON				Diameter: 50mm											
DATUM:				Date: Apr-11-2023											
BH LOCATION: Refer to Borehole Location Plan (Drawing 1A) N 4834332.48 E 613466.83				PROJECT NO.: OE231465GG											
				DRAWING NO.: 23											
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)	
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			"N" BLOWS 0.3 m	SHEAR STRENGTH (kPa)		WATER CONTENT (%)					
0.0	Topsoil: 300mm														
0.3	Fill: sandy silt, trace topsoil and rootlets, brown, moist, compact		1	SS	12										
0.6	Silty Sand Till: some clay, greyish brown, moist, compact		2	SS	14										
			3	SS	21										
			4	SS	25										
2.4	End of Borehole Note: Water Levels: (i) During Drilling: -- (ii) At Completion: --														

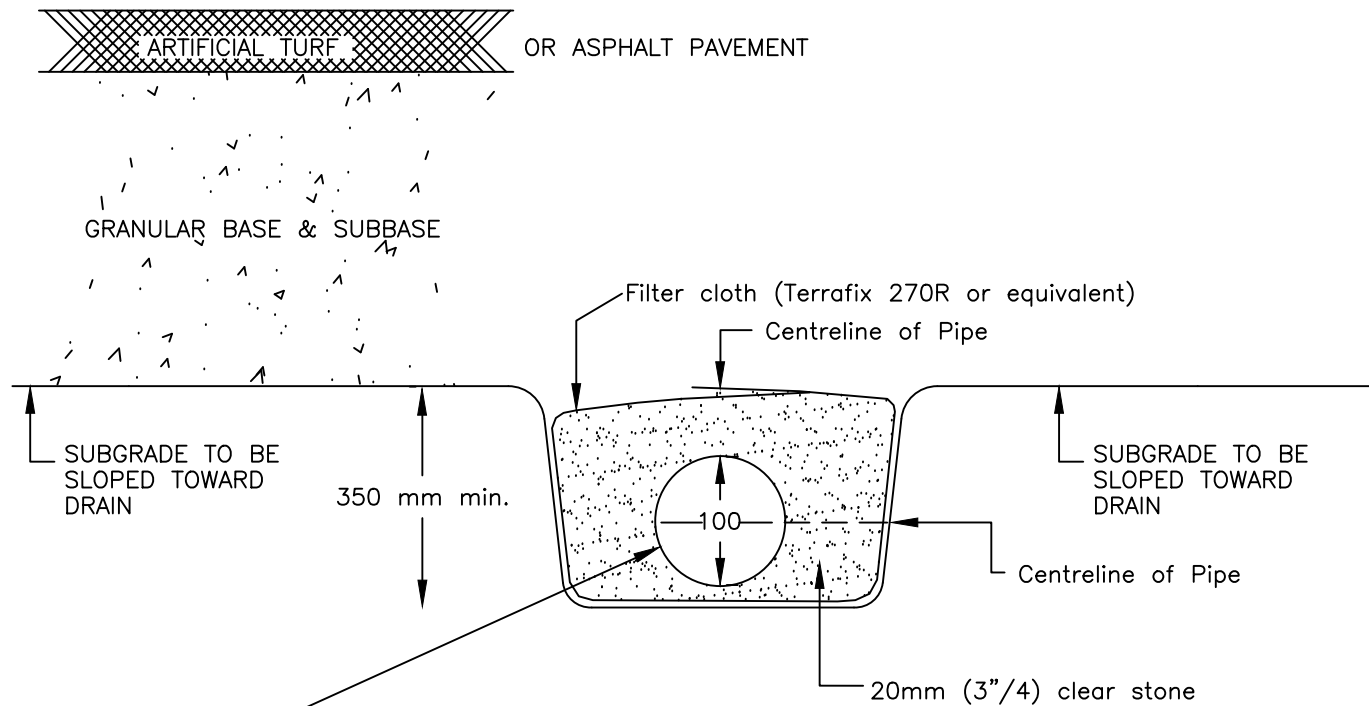
GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES


+ 3, x 3: Numbers refer to Sensitivity

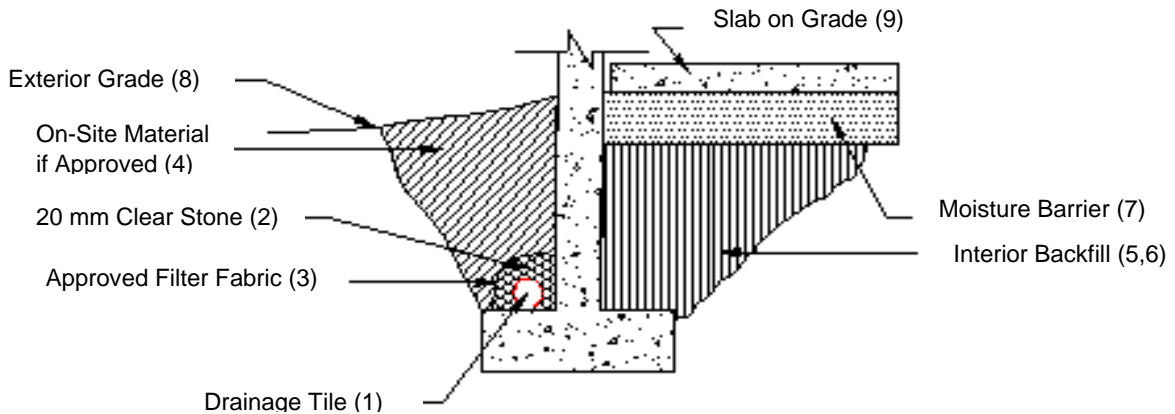
○ s=3% Strain at Failure



100 mm (4") diameter weeping tile seated on 100mm thick layer of 20mm (3"/4) clear stone with 150 mm clear stone on top and sides.

Subdrains to be installed in parallel rows approximately 8 m centre one way with a minimum 0.5% grade and connect to a perimeter drain or positive outlet (ie. ditch or catchbasin).

		TYPICAL SUBDRAIN DETAIL	
		SCALE: NTS	DRAWN BY: Z.A
DATE: August 2023		APPROVED BY: H.A.	
PROJECT NO. 0E231465GG		DRAWING NUMBER: 24	



EXTERIOR FOOTING

Notes

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place 100 mm (4 inches) of stone below drain .
3. Wrap the clear stone with an approved filter fabric (Terrafix 380R or equivalent).
4. The on-site material, if approved, can be used as backfill.
5. The interior fill may be any clean non-organic soil which can be compacted to the specified density in this confined space.
6. Do not use heavy compaction equipment within 450 mm (18") of the wall. Do not fill or compact within 1.8 m (6') of the wall unless fill is placed on both sides simultaneously.
7. Moisture barrier to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors.
8. Exterior grade to slope away from building.
9. Typically, slab on grade is not structurally connected to the wall or footing. However, if it is connected to the wall, it should be designed accordingly.
10. Review the geotechnical report for specific details. Final detail must be approved before system is considered acceptable

DRAINAGE AND BACKFILL RECOMMENDATIONS
Slab on Grade Construction Without Underfloor Drainage
(not to scale)

Appendices

Appendix A

Limitations of Report

LIMITATIONS OF REPORT

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to Orbit Engineering Limited at the time of preparation. Unless otherwise agreed in writing by Orbit Engineering Limited, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Orbit Engineering Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time. Any user of this report specifically denies any right to claims against the Consultant, Sub-Consultants, their officers, agents and employees in excess of the fee paid for professional services.

Appendix B

Geotechnical Laboratory Test Results

UNIFIED SOIL CLASSIFICATION SYSTEM

LS 702/D 422

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

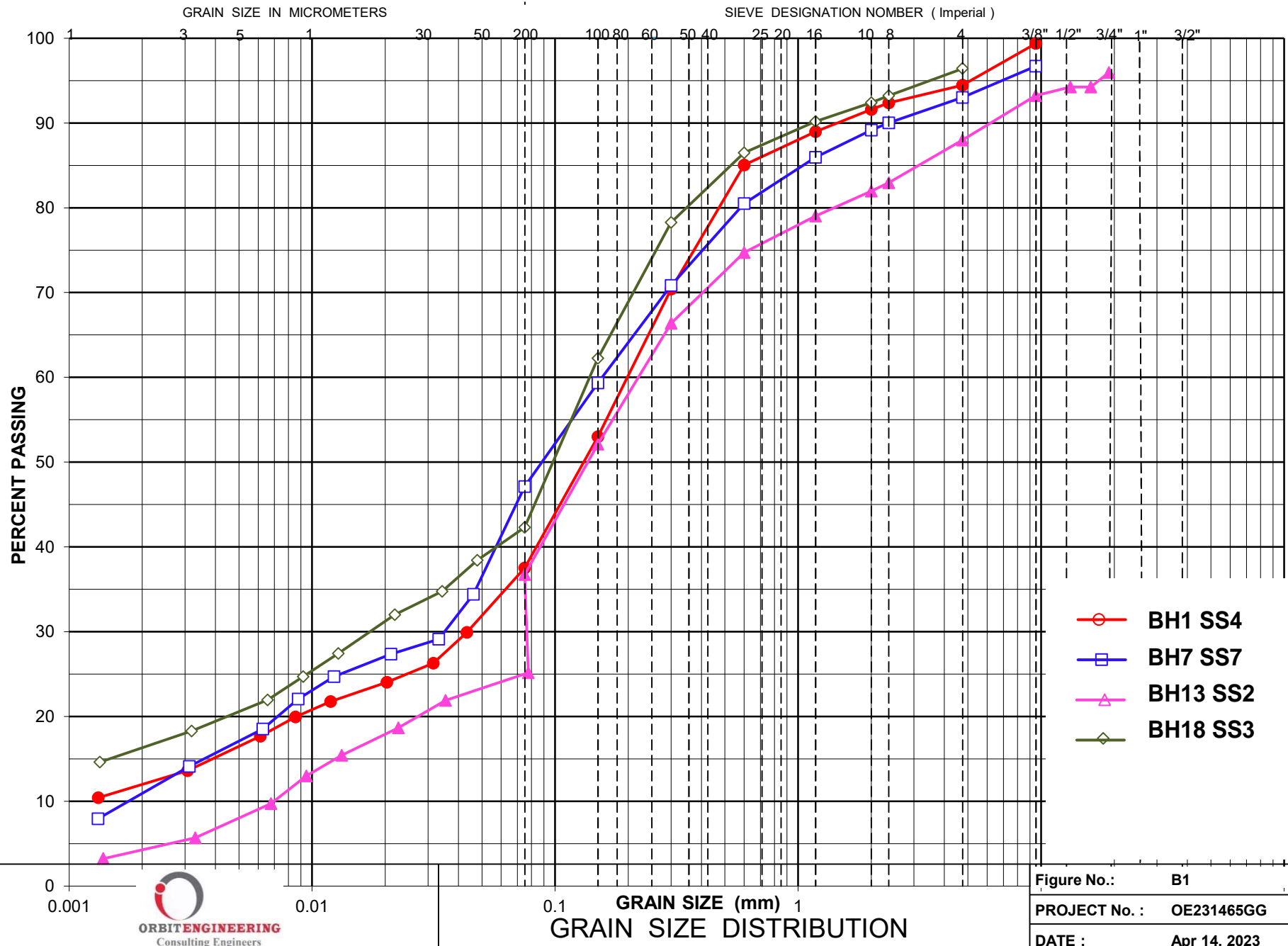


Figure No.: B1

PROJECT No.: OE231465GG

DATE: Apr 14, 2023

Appendix C

Certificate of Analysis

Client: Orbit Engineering
1900 Clark Blvd
Brampton, ON
L6T 0E9
Attention: Mr Hafiz Ahmad
Invoice to: Orbit Engineering
PO#:

Report Number: 1998686
Date Submitted: 2023-06-28
Date Reported: 2023-07-06
Project: OE231465GG
(Centennial Park)
COC #: 908803
Temperature (C): 9
Custody Seal:

Page 1 of 17

Dear Hafiz Ahmad:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Sample Comment Summary

Sample ID: 1693402	BH1 SS5	No jar submitted for moisture determination; VOC results reported on wet weight basis.
Sample ID: 1693404	BH4 SS3	No jar submitted for moisture determination; VOC results reported on wet weight basis.
Sample ID: 1693408	BH6 SS3	No jar submitted for moisture determination; VOC results reported on wet weight basis.

Report Comments:

Raheleh Zafari, Environmental Chemist

All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise stated

Eurofins Environment Testing Canada Inc. is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at <https://directory.cala.ca/>

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline or regulatory limits listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official guideline or regulation as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

Client: Orbit Engineering
1900 Clark Blvd
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Report Number: 1998686
Date Submitted: 2023-06-28
Date Reported: 2023-07-06
Project: OE231465GG
(Centennial Park)
COC #: 908803

O.Reg 153-T1-All Other Soils

Exceedence Summary

Sample I.D.	Analyte	Result	Units	Criteria
Inorganics				
BH1 SS2	Sodium Adsorption Ratio	4.82		STD 2.4
BH7 SS2	Sodium Adsorption Ratio	2.44		STD 2.4

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

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(Centennial Park)
COC #: 908803

Guideline = O.Reg 153-T1-All Other Soils - Res/Par/Ins/Ind/Com/Prop

Hydrocarbons

Lab I.D.
Sample Matrix
Sample Type
Sample Date
Sampling Time
Sample I.D.

1693401
Soil153

2023-06-26

BH1 SS2

1693403
Soil153

2023-06-26

BH4 SS2

Analyte Batch No MRL Units Guideline

PHC's F1	444896	10	ug/g	STD 25	<10	<10
PHC's F2	444891	2	ug/g	STD 10	<2	
	444913	2	ug/g	STD 10		<2
PHC's F2-Naph	445023	2	ug/g		<2	
PHC's F3	444891	20	ug/g	STD 240	30	
	444913	20	ug/g	STD 240		<20
PHC's F3-PAH	445024	20	ug/g		30	
PHC's F4	444891	20	ug/g	STD 120	80	
	444913	20	ug/g	STD 120		<20

Hydrocarbons

Lab I.D.
Sample Matrix
Sample Type
Sample Date
Sampling Time
Sample I.D.

1693406
Soil153

2023-06-26

BH5 SS3

1693407
Soil153

2023-06-26

BH6 SS2

1693410
Soil153

2023-06-26

BH7 SS5

Analyte Batch No MRL Units Guideline

PHC's F1	444896	10	ug/g	STD 25	<10	<10	<10
PHC's F2	444891	2	ug/g	STD 10			10
	444913	2	ug/g	STD 10		<2	
PHC's F3	444891	20	ug/g	STD 240			70
	444913	20	ug/g	STD 240		<20	
PHC's F4	444891	20	ug/g	STD 120			<20
	444913	20	ug/g	STD 120		<20	

Results relate only to the parameters tested on the samples submitted.
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Metals

Lab I.D.
Sample Matrix
Sample Type
Sample Date
Sampling Time
Sample I.D.

1693401
Soil153

2023-06-26

BH1 SS2

1693403
Soil153

2023-06-26

BH4 SS2

1693405
Soil153

2023-06-26

BH5 SS2

Analyte	Batch No	MRL	Units	Guideline			
Antimony	445001	1	ug/g	STD 1.3	<1	<1	<1
Arsenic	445001	1	ug/g	STD 18	4	5	5
Barium	445001	1	ug/g	STD 220	60	61	66
Beryllium	445001	1	ug/g	STD 2.5	<1	<1	<1
Boron (Hot Water Soluble)	445036	0.5	ug/g		<0.5	0.5	<0.5
Boron (total)	445001	5	ug/g	STD 36	7	7	7
Cadmium	445001	0.4	ug/g	STD 1.2	<0.4	<0.4	<0.4
Chromium Total	445001	1	ug/g	STD 70	20	20	19
Chromium VI	444976	0.20	ug/g	STD 0.66	0.28	0.21	<0.20
Cobalt	445001	1	ug/g	STD 21	8	8	9
Copper	445001	1	ug/g	STD 92	22	22	27
Lead	445001	1	ug/g	STD 120	21	21	11
Mercury	445001	0.1	ug/g	STD 0.27	<0.1	<0.1	<0.1
Molybdenum	445001	1	ug/g	STD 2	<1	<1	<1
Nickel	445001	1	ug/g	STD 82	18	17	21
Selenium	445001	0.5	ug/g	STD 1.5	0.6	0.5	<0.5
Silver	445001	0.2	ug/g	STD 0.5	<0.2	<0.2	<0.2
Thallium	445001	1	ug/g	STD 1	<1	<1	<1
Uranium	445001	0.5	ug/g	STD 2.5	0.6	0.6	0.7
Vanadium	445001	2	ug/g	STD 86	28	27	26
Zinc	445001	2	ug/g	STD 290	62	62	45

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(Centennial Park)
COC #: 908803

Guideline = O.Reg 153-T1-All Other Soils - Res/Par/Ins/Ind/Com/Prop

Metals

Lab I.D.
Sample Matrix
Sample Type
Sample Date
Sampling Time
Sample I.D.

1693407
Soil153

2023-06-26

BH6 SS2

1693409
Soil153

2023-06-26

BH7 SS2

1693410
Soil153

2023-06-26

BH7 SS5

Analyte	Batch No	MRL	Units	Guideline			
Antimony	445001	1	ug/g	STD 1.3	<1	<1	<1
Arsenic	445001	1	ug/g	STD 18	4	4	4
Barium	445001	1	ug/g	STD 220	59	57	51
Beryllium	445001	1	ug/g	STD 2.5	<1	<1	<1
Boron (Hot Water Soluble)	445036	0.5	ug/g		<0.5	<0.5	<0.5
Boron (total)	445001	5	ug/g	STD 36	7	8	10
Cadmium	445001	0.4	ug/g	STD 1.2	<0.4	<0.4	<0.4
Chromium Total	445001	1	ug/g	STD 70	19	19	19
Chromium VI	444976	0.20	ug/g	STD 0.66	<0.20	<0.20	<0.20
Cobalt	445001	1	ug/g	STD 21	8	9	9
Copper	445001	1	ug/g	STD 92	22	25	23
Lead	445001	1	ug/g	STD 120	13	9	8
Mercury	445001	0.1	ug/g	STD 0.27	<0.1	<0.1	<0.1
Molybdenum	445001	1	ug/g	STD 2	<1	<1	<1
Nickel	445001	1	ug/g	STD 82	20	21	20
Selenium	445001	0.5	ug/g	STD 1.5	0.5	<0.5	<0.5
Silver	445001	0.2	ug/g	STD 0.5	<0.2	<0.2	<0.2
Thallium	445001	1	ug/g	STD 1	<1	<1	<1
Uranium	445001	0.5	ug/g	STD 2.5	0.6	<0.5	0.6
Vanadium	445001	2	ug/g	STD 86	27	24	24
Zinc	445001	2	ug/g	STD 290	56	53	48

Results relate only to the parameters tested on the samples submitted.
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(Centennial Park)
COC #: 908803

Guideline = O.Reg 153-T1-All Other Soils - Res/Par/Ins/Ind/Com/Prop

PAH

Lab I.D.
Sample Matrix
Sample Type
Sample Date
Sampling Time
Sample I.D.

1693401
Soil153

2023-06-26

BH1 SS2

1693405
Soil153

2023-06-26

BH5 SS2

Analyte	Batch No	MRL	Units	Guideline		
1+2-methylnaphthalene	444885	0.05	ug/g		<0.05	<0.05
Acenaphthene	444884	0.05	ug/g	STD 0.072	<0.05	<0.05
Acenaphthylene	444884	0.05	ug/g	STD 0.093	<0.05	<0.05
Anthracene	444884	0.05	ug/g	STD 0.16	<0.05	<0.05
Benz[a]anthracene	444884	0.05	ug/g	STD 0.36	<0.05	<0.05
Benzo[a]pyrene	444884	0.05	ug/g	STD 0.3	<0.05	<0.05
Benzo[b]fluoranthene	444884	0.05	ug/g	STD 0.47	<0.05	<0.05
Benzo[ghi]perylene	444884	0.05	ug/g	STD 0.68	<0.05	<0.05
Benzo[k]fluoranthene	444884	0.05	ug/g	STD 0.48	<0.05	<0.05
Chrysene	444884	0.05	ug/g	STD 2.8	<0.05	<0.05
Dibenz[a h]anthracene	444884	0.05	ug/g	STD 0.1	<0.05	<0.05
Fluoranthene	444884	0.05	ug/g	STD 0.56	<0.05	<0.05
Fluorene	444884	0.05	ug/g	STD 0.12	<0.05	<0.05
Indeno[1 2 3-cd]pyrene	444884	0.05	ug/g	STD 0.23	<0.05	<0.05
Methylnaphthalene, 1-	444884	0.05	ug/g	STD 0.59	<0.05	<0.05
Methylnaphthalene, 2-	444884	0.05	ug/g	STD 0.59	<0.05	<0.05
Naphthalene	444884	0.013	ug/g	STD 0.09	<0.013	<0.013
Phenanthrene	444884	0.05	ug/g	STD 0.69	<0.05	<0.05
Pyrene	444884	0.05	ug/g	STD 1	<0.05	<0.05

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

Client: Orbit Engineering
1900 Clark Blvd
Brampton, ON
L6T 0E9
Attention: Mr Hafiz Ahmad
PO#:
Invoice to: Orbit Engineering

Report Number: 1998686
Date Submitted: 2023-06-28
Date Reported: 2023-07-06
Project: OE231465GG
(Centennial Park)
COC #: 908803

Guideline = O.Reg 153-T1-All Other Soils - Res/Par/Ins/Ind/Com/Prop

PAH

Lab I.D. 1693409
Sample Matrix Soil153
Sample Type
Sample Date 2023-06-26
Sampling Time
Sample I.D. BH7 SS2

Analyte	Batch No	MRL	Units	Guideline	
1+2-methylnaphthalene	444885	0.05	ug/g		<0.05
Acenaphthene	444884	0.05	ug/g	STD 0.072	<0.05
Acenaphthylene	444884	0.05	ug/g	STD 0.093	<0.05
Anthracene	444884	0.05	ug/g	STD 0.16	<0.05
Benz[a]anthracene	444884	0.05	ug/g	STD 0.36	<0.05
Benzo[a]pyrene	444884	0.05	ug/g	STD 0.3	<0.05
Benzo[b]fluoranthene	444884	0.05	ug/g	STD 0.47	<0.05
Benzo[ghi]perylene	444884	0.05	ug/g	STD 0.68	<0.05
Benzo[k]fluoranthene	444884	0.05	ug/g	STD 0.48	<0.05
Chrysene	444884	0.05	ug/g	STD 2.8	<0.05
Dibenz[a h]anthracene	444884	0.05	ug/g	STD 0.1	<0.05
Fluoranthene	444884	0.05	ug/g	STD 0.56	<0.05
Fluorene	444884	0.05	ug/g	STD 0.12	<0.05
Indeno[1 2 3-cd]pyrene	444884	0.05	ug/g	STD 0.23	<0.05
Methylnaphthalene, 1-	444884	0.05	ug/g	STD 0.59	<0.05
Methylnaphthalene, 2-	444884	0.05	ug/g	STD 0.59	<0.05
Naphthalene	444884	0.013	ug/g	STD 0.09	<0.013
Phenanthrene	444884	0.05	ug/g	STD 0.69	<0.05
Pyrene	444884	0.05	ug/g	STD 1	<0.05

Results relate only to the parameters tested on the samples submitted.
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Guideline = O.Reg 153-T1-All Other Soils - Res/Par/Ins/Ind/Com/Prop

Volatiles

Lab I.D. 1693402 1693404
Sample Matrix Soil153 Soil153
Sample Type
Sample Date 2023-06-26 2023-06-26
Sampling Time
Sample I.D. BH1 SS5 BH4 SS3

Analyte Batch No MRL Units Guideline

Benzene	444896	0.0068	ug/g	STD 0.02	<0.0068	<0.0068
Ethylbenzene	444896	0.018	ug/g	STD 0.05	<0.018	<0.018
Toluene	444896	0.08	ug/g	STD 0.2	<0.08	<0.08
Xylene Mixture	444902	0.05	ug/g	STD 0.05	<0.05	<0.05
Xylene, m/p-	444896	0.05	ug/g		<0.05	<0.05
Xylene, o-	444896	0.05	ug/g		<0.05	<0.05

Volatiles

Lab I.D. 1693408
Sample Matrix Soil153
Sample Type
Sample Date 2023-06-26
Sampling Time
Sample I.D. BH6 SS3

Analyte Batch No MRL Units Guideline

Benzene	444896	0.0068	ug/g	STD 0.02	<0.0068
Ethylbenzene	444896	0.018	ug/g	STD 0.05	<0.018
Toluene	444896	0.08	ug/g	STD 0.2	<0.08
Xylene Mixture	444902	0.05	ug/g	STD 0.05	<0.05
Xylene, m/p-	444896	0.05	ug/g		<0.05
Xylene, o-	444896	0.05	ug/g		<0.05

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(Centennial Park)
COC #: 908803

Guideline = O.Reg 153-T1-All Other Soils - Res/Par/Ins/Ind/Com/Prop

Inorganics

Analyte	Batch No	MRL	Units	Guideline	Lab I.D.	Sample Matrix	Sample Type	Sample Date	Sampling Time	Sample I.D.
					1693401	Soil153		2023-06-26		BH1 SS2
Cyanide (CN-)	445028	0.005	ug/g	STD 0.051	<0.005	<0.005	<0.005			
Electrical Conductivity	445009	0.05	mS/cm	STD 0.57	0.35	0.42	0.40			
pH - CaCl2	445031	2.00			7.72	7.67	7.68			
Sodium Adsorption Ratio	445032	0.01		STD 2.4	4.82*	0.72	1.62			

Inorganics

Analyte	Batch No	MRL	Units	Guideline	Lab I.D.	Sample Matrix	Sample Type	Sample Date	Sampling Time	Sample I.D.
					1693407	Soil153		2023-06-26		BH6 SS2
Cyanide (CN-)	445028	0.005	ug/g	STD 0.051	<0.005	<0.005	<0.005			
Electrical Conductivity	445009	0.05	mS/cm	STD 0.57	0.32	0.52	0.41			
pH - CaCl2	445031	2.00			7.70	7.75	7.93			
Sodium Adsorption Ratio	445032	0.01		STD 2.4	0.27	2.44*	0.77			

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Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim
Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial
Water Quality Guideline, IPWQO = Interim Provincial Water Quality
Objective, TDR = Typical Desired Range

Client: Orbit Engineering
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(Centennial Park)
COC #: 908803

Guideline = O.Reg 153-T1-All Other Soils - Res/Par/Ins/Ind/Com/Prop

Moisture

Lab I.D.	1693401	1693403
Sample Matrix	Soil153	Soil153
Sample Type		
Sample Date	2023-06-26	2023-06-26
Sampling Time		
Sample I.D.	BH1 SS2	BH4 SS2

Analyte	Batch No	MRL	Units	Guideline
---------	----------	-----	-------	-----------

Moisture-Humidite	444891	0.1	%		10.3	
	444913	0.1	%			21.8

Moisture

Lab I.D.	1693407	1693410
Sample Matrix	Soil153	Soil153
Sample Type		
Sample Date	2023-06-26	2023-06-26
Sampling Time		
Sample I.D.	BH6 SS2	BH7 SS5

Analyte	Batch No	MRL	Units	Guideline
---------	----------	-----	-------	-----------

Moisture-Humidite	444891	0.1	%			8.0
	444913	0.1	%		9.4	

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

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PHC Surrogate

Lab I.D.
Sample Matrix
Sample Type
Sample Date
Sampling Time
Sample I.D.

1693401
Soil153
2023-06-26
BH1 SS2

1693403
Soil153
2023-06-26
BH4 SS2

Analyte Batch No MRL Units Guideline

Alpha-androstrane

444891

0

%

66

444913

0

%

104

PHC Surrogate

Lab I.D.
Sample Matrix
Sample Type
Sample Date
Sampling Time
Sample I.D.

1693407
Soil153
2023-06-26
BH6 SS2

1693410
Soil153
2023-06-26
BH7 SS5

Analyte Batch No MRL Units Guideline

Alpha-androstrane

444891

0

%

120

444913

0

%

97

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Client: Orbit Engineering
1900 Clark Blvd
Brampton, ON
L6T 0E9
Attention: Mr Hafiz Ahmad
PO#:
Invoice to: Orbit Engineering

Report Number: 1998686
Date Submitted: 2023-06-28
Date Reported: 2023-07-06
Project: OE231465GG
(Centennial Park)
COC #: 908803

Guideline = O.Reg 153-T1-All Other Soils - Res/Par/Ins/Ind/Com/Prop

VOCs Surrogates

Lab I.D.	1693402	1693404
Sample Matrix	Soil153	Soil153
Sample Type		
Sample Date	2023-06-26	2023-06-26
Sampling Time		
Sample I.D.	BH1 SS5	BH4 SS3

Analyte	Batch No	MRL	Units	Guideline
---------	----------	-----	-------	-----------

Toluene-d8	444896	0	%	98	99
------------	--------	---	---	----	----

VOCs Surrogates

Lab I.D.	1693408
Sample Matrix	Soil153
Sample Type	
Sample Date	2023-06-26
Sampling Time	
Sample I.D.	BH6 SS3

Analyte	Batch No	MRL	Units	Guideline
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Toluene-d8	444896	0	%	99
------------	--------	---	---	----

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(Centennial Park)
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Quality Assurance Summary

Batch No	Analyte	Blank	QC % Rec	QC Limits	Spike % Rec	Spike Limits	Dup % RPD	Duplicate Limits
444884	Methlynaphthalene, 1-	<0.05 ug/g	75	50-140	60	50-140	0	0-40
444884	Methlynaphthalene, 2-	<0.05 ug/g	68	50-140	59	50-140	0	0-40
444884	Acenaphthene	<0.05 ug/g	63	50-140	57	50-140	0	0-40
444884	Acenaphthylene	<0.05 ug/g	59	50-140	53	50-140	0	0-40
444884	Anthracene	<0.05 ug/g	77	50-140	73	50-140	0	0-40
444884	Benz[a]anthracene	<0.05 ug/g	69	50-140	62	50-140	0	0-40
444884	Benzo[a]pyrene	<0.05 ug/g	65	50-140	65	50-140	0	0-40
444884	Benzo[b]fluoranthene	<0.05 ug/g	53	50-140	55	50-140	0	0-40
444884	Benzo[ghi]perylene	<0.05 ug/g	51	50-140	66	50-140	0	0-40
444884	Benzo[k]fluoranthene	<0.05 ug/g	55	50-140	51		0	0-40
444884	Chrysene	<0.05 ug/g	69	50-140	69	50-140	0	0-40
444884	Dibenz[a h]anthracene	<0.05 ug/g	57	50-140	60	50-140	0	0-40
444884	Fluoranthene	<0.05 ug/g	80	50-140	72	50-140	0	0-40
444884	Fluorene	<0.05 ug/g	60	50-140	54	50-140	0	0-40
444884	Indeno[1 2 3-cd]pyrene	<0.05 ug/g	57	50-140	58	50-140	0	0-40
444884	Naphthalene	<0.013 ug/g	76	50-140	68	50-140	0	0-40
444884	Phenanthrene	<0.05 ug/g	64	50-140	62	50-140	0	0-40
444884	Pyrene	<0.05 ug/g	75	50-140	71	50-140	0	0-40
444885	1+2-methylnaphthalene							
444891	PHC's F2	<2 ug/g	92	80-120	114	60-140	0	0-30
444891	PHC's F3	<20 ug/g	92	80-120	114	60-140	0	0-30
444891	PHC's F4	<20 ug/g	92	80-120	114	60-140	0	0-30
444891	Moisture-Humidite	<0.1 %	100	80-120			20	
444896	Benzene	<0.0068	116	60-130	114	50-140	0	0-50
444896	Ethylbenzene	<0.018 ug/g	112	60-130	121	50-140	0	0-50
444896	PHC's F1	<10 ug/g	93	80-120	99	60-140	0	0-30
444896	Xylene, m/p-	<0.05 ug/g	116	60-130	112	50-140	0	0-50
444896	Xylene, o-	<0.05 ug/g	110	60-130	118	50-140	0	0-50
444896	Toluene	<0.08 ug/g	117	60-130	114	50-140	0	0-50
444902	Xylene Mixture							
444913	PHC's F2	<2 ug/g	80	80-120	113	60-140	0	0-30
444913	PHC's F3	<20 ug/g	80	80-120	113	60-140	0	0-30

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(Centennial Park)
COC #: 908803

Quality Assurance Summary

Batch No	Analyte	Blank	QC % Rec	QC Limits	Spike % Rec	Spike Limits	Dup % RPD	Duplicate Limits
444913	PHC's F4	<20 ug/g	80	80-120	113	60-140	0	0-30
444913	Moisture-Humidite	<0.1 %	100	80-120			1	
444976	Chromium VI	<0.20 ug/g	98	70-130	93	70-130	0	0-35
445001	Silver	<0.2 ug/g	84	70-130	17	70-130	0	0-20
445001	Arsenic	<1 ug/g	84	70-130	96	70-130	0	0-20
445001	Boron (total)	<5 ug/g	93	70-130	147	70-130	0	0-20
445001	Barium	<1 ug/g	90	70-130	162	70-130	1	0-20
445001	Beryllium	<1 ug/g	90	70-130	94	70-130	0	0-20
445001	Cadmium	<0.4 ug/g	97	70-130	102	70-130	0	0-20
445001	Cobalt	<1 ug/g	90	70-130	98	70-130	1	0-20
445001	Chromium Total	<1 ug/g	91	70-130	169	70-130	4	0-20
445001	Copper	<1 ug/g	94	70-130	106	70-130	0	0-20
445001	Mercury	<0.1 ug/g	100	70-130	90	70-130	0	0-20
445001	Molybdenum	<1 ug/g	90	70-130	94	70-130	0	0-20
445001	Nickel	<1 ug/g	90	70-130	113	70-130	3	0-20
445001	Lead	<1 ug/g	91	70-130	93	70-130	3	0-20
445001	Antimony	<1 ug/g	77	70-130	76	70-130	0	0-20
445001	Selenium	<0.5 ug/g	95	70-130	100	70-130	0	0-20
445001	Thallium	<1 ug/g	91	70-130	89	70-130	0	0-20
445001	Uranium	<0.5 ug/g	86	70-130	90	70-130	0	0-20
445001	Vanadium	<2 ug/g	90	70-130	150	70-130	0	0-20
445001	Zinc	<2 ug/g	100	70-130	70	70-130	6	0-20
445009	Electrical Conductivity	<0.05	99	90-110			0	0-10
445023	PHC's F2-Napth							
445024	PHC's F3-PAH							
445028	Cyanide (CN-)	<0.005 ug/g	84	75-125	94	70-130	0	0-20
445031	pH - CaCl2	5.80	99	90-110			0	
445032	Sodium Adsorption Ratio	<0.01					6	
445036	Boron (Hot Water Soluble)	<0.5 ug/g	99	70-130	112	60-140	0	0-30

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(Centennial Park)
COC #: 908803

Test Summary

Batch No	Analyte	Instrument	Preparation Date	Analysis Date	Analyst	Method
444884	Methylnaphthalene, 1-	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Methylnaphthalene, 2-	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Acenaphthene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Acenaphthylene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Anthracene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Benz[a]anthracene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Benzo[a]pyrene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Benzo[b]fluoranthene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Benzo[ghi]perylene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Benzo[k]fluoranthene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Chrysene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Dibenz[a h]anthracene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Fluoranthene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Fluorene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Indeno[1 2 3-cd]pyrene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Naphthalene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Phenanthrene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444884	Pyrene	GC-MS	2023-07-04	2023-07-04	C_M	P 8270
444885	1+2-methylnaphthalene	GC-MS	2023-07-05	2023-07-05	C_M	P 8270
444891	PHC's F2	GC/FID	2023-07-05	2023-07-05	SS	CCME
444891	PHC's F3	GC/FID	2023-07-05	2023-07-05	SS	CCME
444891	PHC's F4	GC/FID	2023-07-05	2023-07-05	SS	CCME
444891	Moisture-Humidite	Oven	2023-07-05	2023-07-05	SS	ASTM 2216
444896	Benzene	GC-MS	2023-07-04	2023-07-04	PJ	V 8260B
444896	Ethylbenzene	GC-MS	2023-07-04	2023-07-04	PJ	V 8260B
444896	PHC's F1	GC/FID	2023-07-04	2023-07-04	PJ	CCME
444896	Xylene, m/p-	GC-MS	2023-07-04	2023-07-04	PJ	V 8260B
444896	Xylene, o-	GC-MS	2023-07-04	2023-07-04	PJ	V 8260B
444896	Toluene	GC-MS	2023-07-04	2023-07-04	PJ	V 8260B
444902	Xylene Mixture	GC-MS	2023-07-05	2023-07-05	PJ	V 8260B
444913	PHC's F2	GC/FID	2023-07-05	2023-07-05	SS	CCME
444913	PHC's F3	GC/FID	2023-07-05	2023-07-05	SS	CCME

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Test Summary

Batch No	Analyte	Instrument	Preparation Date	Analysis Date	Analyst	Method
444913	PHC's F4	GC/FID	2023-07-05	2023-07-05	SS	CCME
444913	Moisture-Humidite	Oven	2023-07-05	2023-07-05	SS	ASTM 2216
444976	Chromium VI	FAA	2023-07-05	2023-07-05	MW	M US EPA 3060A
445001	Silver	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Arsenic	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Boron (total)	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Barium	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Beryllium	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Cadmium	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Cobalt	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Chromium Total	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Copper	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Mercury	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Molybdenum	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Nickel	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Lead	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Antimony	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Selenium	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Thallium	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Uranium	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Vanadium	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445001	Zinc	ICAPQ-MS	2023-07-06	2023-07-06	SD	EPA 200.8/6020
445009	Electrical Conductivity	Electrical Conductivity Meter	2023-07-06	2023-07-06	SKH	Cond-Soil
445023	PHC's F2-Naph	GC/FID	2023-07-06	2023-07-06	SS	CCME
445024	PHC's F3-PAH	GC/FID	2023-07-06	2023-07-06	SS	CCME
445028	Cyanide (CN-)	Skalar CN Analyzer	2023-07-06	2023-07-06	Z_S	MOECC E3015
445031	pH - CaCl2	pH Meter	2023-07-06	2023-07-06	IP	Ag Soil
445032	Sodium Adsorption Ratio	iCAP OES	2023-07-06	2023-07-06	Z_S	Ag Soil
445036	Boron (Hot Water Soluble)	iCAP OES	2023-07-06	2023-07-06	Z_S	MOECC E3470

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CWS for Petroleum Hydrocarbons in Soil - Tier 1

Notes:

1. The laboratory method complies with CCME Tier 1 reference method for PHC in soil. It is validated for laboratory use.
2. Where the F1 fraction (C6 to C10) and BTEX are both measured, F1-BTEX is reported.
3. Where the F2 fraction (C10 to C16) and naphthalene are both measured, F2-naphthalene is reported.
4. Where the F3 fraction (C16 to C34) and PAHs* are both measured, F3-PAH is reported.
5. F4G is analyzed if the chromatogram does not descend to baseline before C50. Where F4 (C34 to C50) and F4G are both reported, the higher result is compared to the standard.
6. Unless otherwise stated in the sample comments, the following criteria have been met where applicable:
 - nC6 and nC10 response factors within 30% of response factor for toluene;
 - nC10, nC16, and nC34 response factors within 10% of each other;
 - C50 response factors within 70% of nC10 + nC16 + nC34 average; and,
 - Linearity is within 15%.
7. Unless otherwise stated in the sample comments, sampling requirements and analytical holding times have been met.
8. Gravimetric heavy hydrocarbons (F4G) cannot be added to the C6 and C50 hydrocarbons.
9. *PAHs = phenanthrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene and pyrene.

Certificate of Analysis

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Project: OE231465GG (Centennial Park)
COC #: 908806

Page 1 of 4

Dear Hafiz Ahmad:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Report Comments:

APPROVAL:

Raheleh Zafari, Environmental Chemist

All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise indicated.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at: <https://directory.cala.ca/>.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is licensed by the Ontario Ministry of the Environment, Conservation, and Parks (MECP) for specific tests in drinking water (license #2318). A copy of the license is available upon request.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by the Ontario Ministry of Agriculture, Food, and Rural Affairs for specific tests in agricultural soils.

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline values listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official provincial or federal guideline as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

Certificate of Analysis

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COC #: 908806

					Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D.	1693391 Soil 2023-06-26 BH1 - (Fill)	1693392 Soil 2023-06-26 BH7 - (Fill)	1693393 Soil 2023-06-26 BH13 - (Native)
Group	Analyte	MRL	Units	Guideline				
Anions	Cl	0.002	%			0.015	0.028	0.022
	SO4	0.01	%			<0.01	<0.01	<0.01
General Chemistry	Electrical Conductivity	0.05	mS/cm			0.38	0.43	0.33
	pH	2.00				7.85	8.02	8.60
	Resistivity	1	ohm-cm			2632	2326	3030
Moisture	Moisture-Humidite	0.1	%			12.8	8.9	9.8
Redox Potential	REDOX Potential		mV			283	259	278
Subcontract	S2-	0.04	%			<0.04	0.04	<0.04

Guideline = * = Guideline Exceedence

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COC #: 908806

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 444888 Analysis/Extraction Date 2023-07-05 Analyst AsA Method C SM2580B			
REDOX Potential	296 mV	100	97-103
Run No 444911 Analysis/Extraction Date 2023-07-05 Analyst AsA Method C CSA A23.2-4B			
Chloride	<0.002 %		90-110
Run No 445018 Analysis/Extraction Date 2023-07-06 Analyst IP Method ASTM 2216			
Moisture-Humidite			80-120
Run No 445020 Analysis/Extraction Date 2023-07-06 Analyst IP Method Cond-Soil			
Electrical Conductivity	<0.05 mS/cm	100	90-110
pH	6.50	99	90-110
Resistivity			
Run No 445026 Analysis/Extraction Date 2023-07-06 Analyst IP Method AG SOIL			
SO4	<0.01 %	97	70-130
Run No 445943 Analysis/Extraction Date 2023-07-24 Analyst AET Method SUBCONTRACT-SGS			

Guideline =

* = Guideline Exceedence

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QC Summary

Analyte	Blank	QC % Rec	QC Limits
S2-			

Guideline =*** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

1 **GENERAL**

- 1.1 The requirements of the Articles of Agreement, Conditions of the Contract, Division 1 apply to and form all Sections of the Contract Documents and the Work.
- 1.2 Work in this Specification is divided into descriptive sections which are not intended to identify absolute contractual limits between Subcontractors, nor between the Contractor and their Subcontractors. The Contractor is responsible for organizing division of labour and supply of materials essential to complete the Contract. The Consultant assumes no liability to act as an arbiter to establish subcontract limits between Sections or Divisions of Work.
- 1.3 It is intended that Work supplied under these Contract Documents shall be complete and fully operational in every detail for the purpose required. Provide all items, articles, materials, services and incidentals, whether or not expressly specified or shown on Drawings, to make finished Work complete and fully operational, consistent with the intent of the Contract Documents.
- 1.4 Work designated as “N.I.C.” is not included in this Contract.
- 1.5 Specifications, Schedules and Drawings are complementary and items mentioned or indicated on one may not be mentioned or indicated on the others.
- 1.6 Contractors finding discrepancies or ambiguities in, or omissions from the Drawings, Specifications or other Contract Documents, or having doubt as to the meaning and intent of any part thereof shall contact the Consultant for clarification. If the Consultant is not contacted for clarification, execute the Work in accordance with the most stringent requirements.
- 1.7 Mention in the specifications or indication on the drawings of materials, Products, operations, or methods, requires that the Contractor provide each item mentioned or indicated of the quality or subject to the qualifications noted; perform according to the conditions stated in each operation prescribed; and provide labour, materials, Products, equipment and services to complete the Work.
- 1.8 Where the singular or masculine is used in the Contract Documents, it shall be read and construed as if the plural, feminine or neuter had been used when the context or the statement so requires and as required to complete the Work, and the rest of the sentence, clause, paragraph, or Article shall be construed as if all changes in grammar, gender or terminology thereby rendered necessary had been made.
- 1.9 The terms “approved”, “review”, “reviewed”, “accepted”, “acceptance”, “acceptable”, “satisfactory”, “selected”, “directed”, “instructed”, “required”, “submit”, “permitted” or similar words or phrases are used in standards or elsewhere in Contract Documents, it shall be understood, that words “by (to) the Consultant” follow, unless context provides otherwise.

1.10 Where the words 'submit', 'acceptable' and 'satisfactory' are used in the Contract Documents, they shall be considered to be followed by the words 'to the Consultant' unless the context provides otherwise.

1.11 The terms “exposed” or “exposed to view” refers to surfaces that are within the line of vision of persons from any accessible viewpoint, both within and without the building. Where any part of a surface is exposed to view, all other portions of that surface shall also be considered as exposed to view.

2 PROGRESS AND COMPLETION

2.1 **Start of construction: Monday, March 3rd, 2025.**

2.2 **Substantial Performance of the Work shall be on or before Monday March 2nd, 2026.**

2.3 **Contract Completion of the Work shall be on Friday, March 27th, 2026.**

3 EXISTING SITE CONDITIONS

3.1 Make a careful examination of the site, and investigate and be satisfied as to all matters relating to the nature of the Work to be undertaken, as to the means of access and egress thereto and therefrom, as to the obstacles to be met with, as to the extent of the Work to be performed, any limitations under which the work has to be executed, and any and all matters which are referred to in the Contract Documents. Claims for additional costs will not be entertained with respect to conditions which could reasonably have been ascertained by an inspection prior to Tender closing.

3.2 Report any inconsistencies, ambiguities, discrepancies, omissions, and errors between Site conditions and Contract Documents to the Consultant prior to the commencement of Work. If inconsistencies, ambiguities, discrepancies, omissions, and errors are not reported and clarified, the most stringent requirement shall govern, as determined by the Consultant. Ensure that each Subcontractor performing work related to the site conditions has examined it so that all are fully informed on all particulars which affect the Work thereon in order that construction proceeds competently and expeditiously.

3.3 Before commencing the Work of any Section or trade, carefully examine the Work of other Sections and trades upon which it may depend, examine substrate surfaces, and report in writing to the Consultant, defects which might affect new Work. Commencement of Work shall constitute acceptance of conditions and Work of other sections, trades, and Other Contractors upon which the new Work depends. If repair of surfaces is required after commencement of specific work it shall be included in the work of the trade providing the specific system or finish.

4 USE OF SITE

- 4.1 Accept full responsibility for assigned work and storage areas from the time of Contract award until Substantial Performance of the Work.
- 4.2 Check means of access and egress, rights and interests which may be interfered with. Do not block lanes, roadways, entrances or exits. Direct construction traffic and locate access to site as directed by municipality.
- 4.3 Where encroachment beyond property limits is necessary make arrangements with respective property owners.
- 4.4 Before vehicles or equipment enter the Site, obtain permission from the Owner/Consultant for storage and appropriate access route. Appropriately barricade, stake off, or snow fence access route and storage area and around construction area in order to minimize damage to buildings, grounds, planting, turf, and surrounding facilities at the Site, and to restrict unauthorized persons from entering the construction area. Be responsible for making good any/all damages caused by operations at the Site. Restoration of such damages shall be to original condition and to the satisfaction of the Owner.
- 4.5 Cost of providing temporary protection, roads and services, including removal of same at completion of the Work and restoration of the involved areas to original state, shall be included in the Bid Price."
- 4.6 Maintain the exterior of the building during performance of the work. Proper housekeeping measures to maintain a neat and orderly site to eliminate any complaints from surrounding neighbours.

5 ACCESS/PROPERTY CONSTRAINTS

- 5.1 Refer to Owner's front end for additional requirements regarding access and property constraints.
- 5.2 Provide and maintain access facilities as may be required for access to the Work.
- 5.3 Minimize disruption, noise and dust to the functions of existing operational areas of existing buildings. Times of entry, routes of access and time required to complete the Work shall be arranged and scheduled in cooperation with the Owner.
- 5.4 Confine Work and operations of employees to limits indicated by the Contract Documents. Do not unreasonably encumber the premises with products.
- 5.5 Organize delivery of materials/equipment to and removal of debris and equipment from place of Work to permit continual progress of work and suitable for restricted site conditions.

- 5.6 Determine and make arrangement as required for loading and unloading of equipment and Products at times that will not affect public traffic flow and that will be permitted by the City of Toronto. Conform to City by-laws with regard to parking restrictions and other conditions.
- 5.7 Make provisions and arrangements and provide allowances if times for loading and unloading allowed by the City of Toronto are other than regular working hours.
- 5.8 All Products, materials and equipment required on Site shall be portable and/or size suitable for access and movement on Site and without causing damage to buildings.
- 5.9 The Work shall be confined to the area defined on the drawings and by the property lines except that services connections and certain portions of landscaping, hard paving and curb work shall be executed on Municipal property under regulation of authorities.
- 5.10 Provide locked doors in barriers, permit access by Owner and Consultant to Work areas and to areas Contractor is responsible for.
- 5.11 Workers shall not enter existing building beyond construction areas except where required for connection or modification to existing services or other such work. Arrange such requirements with Owner prior to entering existing occupied areas.
- 5.12 Advise the Owner 48 hours in advance of large or cumbersome item deliveries. Give particulars of item size and weight, protection to existing surfaces to be provided and safety precautions during movement.
- 6 **SECURITY**
- 6.1 Be responsible for security of all areas affected by Work of this Contract until taken over by Owner. Take steps to prevent entry to the Work by unauthorized persons and guard against theft, fire and damage by any cause. Provide safe and secure access to and egress from existing premises at all times.
- 6.2 Provide suitable surveillance equipment and/or employ guard services, as required to adequately protect the work.
- 6.3 Make provisions to permit Owner's security personnel to view areas where all Work is being performed.

- 6.4 Use of facilities such as building entrances, washrooms, elevators and access corridors as directed by Owner's security personnel and as specified.
- 6.5 Take acceptable precautions to guard Work site, premises, materials and the public during and after working hours due to the Work of this Contract.
- 6.6 A regular full time watchman is generally not required on Site, however, if in the opinion of the Consultant the Work is not adequately protected, the Owner may request that a watchman be employed by the Contractor at no extra cost to the Contract.
- 7 CONTINUITY OF EXISTING SERVICES**
- 7.1 Shutdowns and planning of operations that may affect Owner's use of services shall be coordinated with, approved by, and in accordance with the Owner's written directions. Provide advanced notice for all required interruptions to utility, heating, cooling, mechanical, electrical, and life safety systems.
- 7.2 Coordinate and provide necessary services, access, exiting and other facilities as required.
- 7.3 Make written requests for shutdown at least 5 working days in advance, unless specifically stated herein or as otherwise instructed by the Owner.
- 7.4 Shutdowns shall be scheduled in advance with Owner and shutdown period shall be minimized to Owner's convenience. Facilities in existing adjacent areas will be occupied during the Work.
- 7.5 Major shutdowns shall take place on weekends or at night by prior arrangement with and at no additional cost to the Owner.
- 7.6 Tag and mark switches and valves used by the Contractor to isolate services with name of Contractor, tradesman's name, date and time of shut-off, and date and time to be turned back on.
- 7.7 Arrange work so that physical access to existing adjacent facilities is not unduly interrupted at any one time except as approved by the Owner.
- 7.8 Protect existing work to remain at the commencement of each work shift in occupied areas, as completely as possible to hold the replacing of damaged work to a minimum. Provide covering and other protection material. Include protection for access routes and temporary storage areas. Make good damage to existing surfaces caused by lack of adequate protection. Protection in such areas shall be removed at the end of each work shift.
- 7.9 All areas shall be cleaned and left in condition suitable for use by Owner and building operations before commencement of their work day.

7.10 Minimize disruption, vibration, noise and dust to the function of existing building. Refer to Owner's front end for additional noise regulation requirements.

7.11 These requirements are for security reasons and for the consideration of the Owner. Requirements shall not be construed as cause for elimination or restriction of Contractor's working schedule, claims for delay or work, nor additional cost.

8 WEATHER

8.1 Incorporate into the Contract Schedule allowances for the number of working days lost due to inclement weather, which can be anticipated, on the basis of analysis of information available from Environment Canada, for weather conditions on and near the Site, over the last ten (10) years. The Contractor may be entitled to a schedule extension for those activities on the critical path which are delayed on account of inclement weather, assessed on a quarterly basis, by the number of days in excess of the anticipated number of working days for the quarter in question by more than 20%. No additional payment will be made on account of any such schedule extension.

8.2 For the purpose of this clause the quarters are defined as January 1 to March 31, April 1 to June 30, July 1 to September 30, and October 1 to December 31.

9 WASTE AUDIT/PLANS FOR WASTE REDUCTION

9.1 Comply with requirements of authorities having jurisdiction.

9.2 Prepare and submit waste audit and waste reduction plan in accordance with Ontario Regulation 102/94 Waste Audits and Waste Reduction Workplans.

9.3 Prepare and submit source separation plan in accordance with Ontario Regulation 103/94 Industrial, Commercial and Institutional Source Separation Programs.

9.4 Deliver to nearest appropriate depot all materials accepted for recycling by the region or municipality having jurisdiction over the Place of Work, including but not limited to cardboard, paper, plastic, aluminum, steel, and glass. Deliver to nearest appropriate depot all scrap and excess gypsum wallboard for recycling of this material. Pay all costs for this work.

END OF SECTION

1 **GENERAL**

- 1.1 Coordination of the Work of all Sections of the specifications as required to complete the Project is the responsibility of the Contractor.
- 1.2 Cooperate and coordinate with Other Contractors including Other Contractor's employed by Owner.
- 1.3 Ensure that Subcontractors and trades cooperate with other subcontractors and trades whose work attaches to or is affected by their own work. Ensure that minor adjustments are made to make adjustable work fit fixed work.
- 1.4 Allow access of Owner's Other Contractors on site and to areas of Work. Cooperate and coordinate with such Other Contractors. Schedule work to complement work of such Other Contractors.
- 1.5 Entry by the Owner's own forces and by Other Contractors shall not mean acceptance of the Work and shall not relieve the Contractor of their responsibility to complete the Contract.
- 1.6 Placing, installation, application and connection of work by the Owner's own forces or by Other Contractors on and to the Contractor's Work shall not relieve the Contractor of his responsibility to provide and maintain the specified warranties.
- 1.7 Coordinate with removals/installations specified in other Divisions and Other Contracts.
- 1.8 Coordination of the installation of systems specified in Divisions 20, 21, 22, 23, 25, 26, 27 and 28, including the interrelating operation and functioning between components of a system and between systems, is the responsibility of those performing the work of those Divisions, with final coordination the responsibility of the Contractor.
- 1.9 Coordinate relocation of existing mechanical and electrical items with work specified in Divisions 20, 21, 22, 23, 25, 26, 27 and 28.
- 1.10 Existing equipment shall remain in present locations unless designated otherwise. Protect from damage. Remove, store and reinstall existing fixed equipment, fixtures and components which interfere with construction and which are scheduled for relocation.
- 1.11 Pay particular attention to types of ceiling construction and clearances throughout, especially where recessed fixtures are required. Coordinate work with Other Contractors and Subcontractors wherever ventilation ducts or piping installations occur to ensure that conflicts are avoided.
- 1.12 Install ceiling mounted components in accordance with final ceiling plans. Inform Consultant of conflicting installations.

- 1.13 Install and arrange ducts, piping, tubing, conduit, equipment, fixtures, materials and product to conserve headroom and space with minimum interference and in neat, orderly and tidy arrangement. Run pipes, ducts, tubing and conduit, vertical, horizontal and square with building grid unless otherwise indicated. Install piping, ducts, and conduit as close to underside of structure as possible unless shown otherwise.
- 1.14 Make provision, without interference or restriction by items located within the ceiling space, for unrestricted relocation of light fixtures to replace ceiling panels at grid spaces of the same size.
- 1.15 Where supports or openings are to be left for the installation of various parts of the Work furnish the necessary information to those concerned in ample time so that proper provision can be made for such items. Have cutting, drilling and other remedial work, and the subsequent patching or other work required for failing to comply with this requirement, performed at a later date at no additional Cost to Owner.
- 1.16 Properly coordinate the work of the various Sections and trades, taking into account the existing installations to assure the best arrangement of pipes, conduits, ducts and mechanical, electrical and other equipment, in the available space. Under no circumstances will any extra payment be allowed due to the failure by the Contractor to coordinate the work. If required, in critical locations, prepare interference and/or installation drawings showing the work of the various Sections as well as the existing installation, and submit these drawings to the Consultant for review before the commencement of work. Proceed with work in these areas only as, and when directed by the Consultant.
- 1.17 Coordinate with mechanical and electrical trades to ensure protecting supporting, disconnecting, cutting off, capping, diverting, relocating or removing of existing services in areas of Work before commencement of alteration work.
- 1.18 In case of damage to active services on utilities, notify Consultant and respective authorities immediately and make all required repairs under direction of Consultant and respective authorities. Carry out repairs to such damaged services and utilities continuously to completion, including working beyond regular working hours. Costs to be borne by the Contractor.
- 2 **METRIC DIMENSIONS**
- 2.1 Measurements in this specification are expressed in metric (SI) units and depending on the progress made in the various sectors of the industry are either hard or soft converted units.
- 2.2 All metric units specified shall be taken to be the minimum acceptable unless otherwise noted.

2.3 It is the Contractor's responsibility to check and verify with manufacturers and suppliers on the availability of materials and products in either metric or imperial sizes. Be responsible for coordinating products supplied in metric (SI) and imperial units into the overall layout.

2.4 Where both metric and imperial sizes or dimensions are shown, the metric size or dimension shall govern.

3 BUILDING DIMENSIONS

3.1 Take necessary job dimensions for the proper execution of the work. Assume complete responsibility for the accuracy and completeness of such dimensions, and for coordination.

3.2 Verify that work, as it proceeds, is executed in accordance with dimensions and positions indicated which maintain levels and clearances to adjacent work, as set out by requirements of the Drawings, and ensure that work installed in error is rectified before construction resumes.

3.3 Check and verify dimensions referring to the work and the interfacing of services.

3.4 Do not scale directly from the Drawings. If there is ambiguity or lack of information, immediately inform the Consultant. Changes required through the disregarding of this clause shall be the responsibility of the Contractor.

3.5 All details and measurements of any work which is to fit or to conform with work installed shall be taken at the building.

3.6 Advise Consultant of discrepancies and if there are omissions on Drawings, particularly reflected ceiling plans and jointing patterns for surfaces finishes, which affect aesthetics, or which interfere with services, equipment or surfaces. Do not proceed with work affected by such items without direction from the Consultant.

3.7 Provide written requirements for site conditions and surfaces necessary for the execution of respective work, and provide setting drawings, templates and all other information necessary for the location and installation of material, holes, sleeves, inserts, anchors, accessories, fastenings, connections and access panels. Inform respective contractors whose work is affected by these requirements and preparatory work.

4 INTERFERENCE AND COORDINATION DRAWINGS

4.1 Coordinate placement of equipment to ensure that components will be properly accommodated within the spaces provided prior to commencement of work.

4.2 Prepare interference and equipment placing drawings to ensure that all components will be properly accommodated within the spaces provided. Provide copies of interference drawings to Consultant when requested by Consultant.

- 4.3 Prepare drawings to indicate coordination and methods of installation of a system with other systems where their relationship is critical. Ensure that all details of equipment apparatus, and connections are coordinated.
- 4.4 Take complete responsibility for any remedial work that results from failure to coordinate any aspect of the Work prior to its fabrication/installation.
- 4.5 Ensure that accesses and clearance required by jurisdictional authorities and/or for easy maintenance of equipment are provided in the layout of equipment and services.
- 5 **SLEEVING AND INSERT DRAWINGS AND TEMPLATES**
 - 5.1 Prepare sleeving drawings for work of **Divisions 20, 21, 22, 23, 25, 26, 27 and 28**, showing size and location of all penetrations through load bearing elements. Submit sleeving drawings in the form of one transparency and 4 prints to Consultant for review not less than 15 days prior to construction of affected elements.
 - 5.2 Prepare insert setting drawings for work to be cast into concrete and/or mortared into masonry elements. Submit insert setting drawings in the form of a transparency and 4 prints to Consultant for review not less than 15 days prior to construction of affected elements.
 - 5.3 Ensure that setting drawings, templates, and all other information necessary for the location and installation of materials, fixtures, equipment, holes, sleeves, inserts, anchors, accessories, fastenings, connections, and access panels are provided by each Section whose work requires cooperative location and installation by other Sections, and that such information is communicated to the applicable installer.
 - 5.4 Provide cutting, fixing and making good to the work of Other Contractors, Subcontractors and trades as required for sleeving and inserts and make up time lost as a result of failure to comply with this requirement, at no additional cost to the Owner.

END OF DOCUMENT

1 **PRE-CONSTRUCTION MEETING**

- 1.1 The Owner will schedule a preconstruction meeting after award of Contract.
- 1.2 Co-ordinate and organize attendance by representatives of major Subcontractors and parties in contract with the Contractor.
- 1.3 Consultant will arrange attendance of other interested parties not responsible to the Contractor.
- 1.4 Agenda will include but not be limited to the following topics as are pertinent to the Contract.
 - .1 Execution of Project Contract Agreement.
 - .2 Submission of executed bonds and insurance certificates.
 - .3 Distribution of Contract Documents.
 - .4 Review project communications procedures.
 - .5 Submission of List of Subcontractors, Contract, Price Breakdown, Construction Schedule and Proposed Product List.
 - .6 Designation of the personnel representing the parties in the Contract.
 - .7 Procedures and processing of field decisions, submittals, substitutions, applications for payments, Proposal Change Requests, Change Orders and Contract closeout.
 - .8 Scheduling to identify all critical points on construction schedule for positive action.
 - .9 Scheduling of activities of independent inspection and testing laboratories.
 - .10 Identify any product availability problems and substitution requests.
 - .11 Establish site arrangements and temporary facilities.
 - .12 Terms of Payment and proposed cash flow for the project.
 - .13 Project meeting procedures.
- 1.5 Be prepared to provide specific information relative to agenda items as they are pertinent to the Contract.
- 1.6 Record minutes of meeting and distribute type written copies to all participants and other interested parties, within one week of meeting date.

2 **SITE MOBILIZATION MEETING**

- 2.1 Schedule a mobilization meeting at the Project Site, prior to Contractor occupancy. Attendance by:
 - .1 The Consultant
 - .2 Specialized sub-consultants.
 - .3 The Contractor
 - .4 Major subcontractors.
- 2.2 Agenda:
 - .1 Use of the premises by the Contractor.
 - .2 Construction facilities and controls.
 - .3 Temporary facilities.
 - .4 Survey and building layout.
 - .5 Security and housekeeping procedures.
 - .6 Construction Schedule.
 - .7 Application for payment procedures.
 - .8 Procedures for testing.

- .9 Procedures for maintaining record documents.
- .10 Requirements for start-up of equipment.
- .11 Inspection and acceptance of equipment put into service during the construction period.
- 2.3 Record minutes and distribute copies to meeting participants and affected parties not in attendance.
- 3 **PROGRESS MEETINGS**
- 3.1 Attend regularly scheduled progress meetings to be held on Site at times and dates that are mutually agreed to by the Owner, Consultant, and Contractor.
- 3.2 Co-ordinate and organize attendance of individual Subcontractors and material suppliers when requested. Relationships and discussions between Subcontractor participants are not the responsibility of the Consultant and do not form part of the meetings content.
- 3.3 Ensure that Contractor representatives in attendance at meetings have required authority to commit Contractor to actions agreed upon. Assign same persons to attend such meetings throughout the contract period.
- 3.4 Inform the Consultant in advance of meetings regarding all items to be added to the agenda.
- 3.5 Prepare and distribute copies of Agenda prior to meeting.
- 3.6 Be prepared to provide specific information relative to agenda items at each meeting as they are pertinent to the Contract.
- 3.7 Agenda will include but not be limited to the following topics as are pertinent to the Contract.
 - .1 Review of minutes of previous meetings.
 - .2 Review of Work progress.
 - .3 Field observations, problems and decisions. progress.
 - .4 Identification of problems which impede planned progress.
 - .5 Review of Schedule of Submittals and status of submittals.
 - .6 Review of off-site fabrication and delivery schedules.
 - .7 Maintenance of Progress Schedule.
 - .8 Corrective measures to regain projected schedules.
 - .9 Planned progress during succeeding work period.
 - .10 Coordination of projected progress.
 - .11 Maintenance of quality and work standards.
 - .12 Effect of proposed changes on the Progress Schedule and coordination.
 - .13 Other business relating to the Work.
- 3.8 Record minutes. Minutes shall include significant proceedings and decisions and will identify "action by" parties.
- 3.9 Distribute copies to meeting participants and affected parties not in attendance within 2 business days following the meeting.

4 PREINSTALLATION MEETINGS

4.1 When required by individual Sections of the Specification, the Contractor shall:

- .1 Convene a preinstallation meeting at the site or at an appropriate location, prior to commencing the work of the Section.
- .2 Provide minimum two week notice of meeting to all interested parties.
- .3 Require the attendance of parties directly affecting or affected by the work of the Section.
- .4 Distribute written notice of the meeting to all parties required to attend.
- .5 Prepare the agenda and preside at the meeting to review conditions of installation, preparation and installation procedures and review coordination with related work.
- .6 Record minutes and distribute copies to meeting participants and affected parties not in attendance.

END OF SECTION

1. GENERAL

- .1 Be responsible for planning and scheduling of the Work. As a minimum, prepare and update the following schedules:
 - .1 Construction progress schedule.
 - .2 Submittal schedule for shop drawings, product data and samples.
 - .3 Product delivery schedule.
 - .4 Cash allowance schedule for purchasing products.
- .2 Be responsible for ensuring that Subcontractors plan and schedule their respective portions of the Work. Subcontractor's schedules shall form part of the above mentioned schedules.

2. CONTRACT SCHEDULE

- .1 Prepare and submit the Contract Schedule within 10 days following award of Contract. This schedule, once it is reviewed by the Consultant and if it meets the Consultant's project requirements, will form part of the Contract.
- .2 Include schedule for submitting shop drawings, product data, samples, and other submittals called for in the individual specification sections.
- .3 Include in the submittal schedule a complete list of all submittals required for the project.
- .4 Indicate dates for submitting, review time, resubmission time, last date for meeting fabrication schedule.
- .5 The Contract Schedule shall include the following information:
 - .1 Starting and ending dates of each activity including the float periods
 - .2 Labour force requirements for each activity
 - .3 Order and delivery dates for major or critical equipment
 - .4 Interdependency with activities of other Contractors
 - .5 Dates specified in the Contract Documents
 - .6 Dates on which specific data will be required for submittal, i.e., Vendor data, shop drawings, samples, etc.
- .6 This schedule shall be reviewed and updated monthly by the Contractor so as to reflect any Contract changes as well as major changes to the schedule.

3. DETAILED CONSTRUCTION SCHEDULE

- .1 Prepare and submit a detailed construction schedule within 10 days of final review and acceptance of the Contract Schedule. This schedule, once reviewed and accepted by the Consultant, will be updated and submitted monthly with the Contract Schedule and weekly once the Contractor starts on Site.
- .2 This schedule shall cover the construction period. It will show, in detail, activities on a daily basis indicating durations, manpower and constraints. The activities shown on this schedule shall further clarify or detail the activities shown on the Contract Schedule.
- .3 The detailed construction schedule shall be presented in a bar chart form.

4. DAILY REPORTS

- .1 Provide Daily Report (to be submitted weekly)
 - .1 Number of workers on site by trade
 - .2 Work performed by each trade

- .3 Material delivery
- .4 Machinery on site
- .5 Daily photographs for all activities on site

5. CASH FLOW CHART

- .1 Within 10 days after award of Contract, submit, in form approved by Consultant, cash flow chart broken down on a monthly basis in an approved manner. Cash flow chart shall indicate anticipated Contractor's monthly progress billings from commencement of work until completion.
- .2 Update cash flow chart whenever changes occur to scheduling and in manner and at times satisfactory to Consultant.

END OF SECTION

1 **GENERAL**

1.1 Provide labour, Products, equipment, services tools and supervision necessary for submittals. Make submittals specified in this Section to Consultant unless otherwise specified.

- .1 Verify accuracy and completeness of submittals prior to submission.
- .2 Verify field measurements, field construction criteria, catalogue numbers and similar data.
- .3 Co-ordinate each submittal with requirements of the Work and the Contract Documents.
- .4 Notify Consultant in writing at time of submission, of any deviation in submittals from requirements of the Contract Documents.
- .5 Generally, submittals shall be in .pdf digital format. For shop drawings, scanned documents are not acceptable.
- .6 For submittals that cannot be transmitted digitally (i.e. samples), arrange and pay for all deliveries and pick-ups to and from the office of the Consultant.
- .7 Name each submittal file with the project acronym (FIFAEAST), the specification section number, the sequence number, the sequence revision number and a brief description of the content. i.e.: **FIFAEAST – Progress Draw Application**
- .8 Title emails sending submittals the same as the file name (i.e. **FIFAEAST-ProgressDrawApplicationNo.1**).

1.2 Maintain an email inbox capable of accepting minimum 15 Mb of data.

1.3 Submit in accordance with dates established under Section 01 32 13 for shop drawings, fabrication, manufacture, erection and installation to provide adequate time for reviews, securing necessary approvals, possible revisions and resubmittals, placing orders, securing delivery and to avoid construction delays.

1.4 Accompany each submittal with a letter of transmittal in duplicate containing all pertinent information required for identification and checking of submittals including but not limited to the following:

- .1 Date of initial submission and date of each subsequent submission if required.
- .2 Project title and Consultant's project number.
- .3 Names of:
 - .1 Contractor.
 - .2 Subcontractor.
 - .3 Supplier/manufacturer/fabricator as applicable.

- .4 Specification section numbers to which submission is related.
- .5 Countersigned stamp of Contractor certifying that they have reviewed the submission.
- .6 Location (room number, etc)
- .7 On submissions subsequent to the first, the following additional identification:
 - .1 The revised submission number.
 - .2 Identification of the item(s) revised.
- 1.5 Allow two weeks for the Consultant's review of each submission.
- 1.6 When submittals are resubmitted, transmit under a new letter of transmission.
- 1.7 Do not carry out Work until Consultants review of submittals has been completed.
- 1.8 Be responsible for payment of charges for delivery of submissions and resubmission to Consultant.

2 SHOP DRAWINGS AND PRODUCT DATA

- 2.1 Shop drawings to be originals prepared by the Contractor, Subcontractor, Supplier or Distributor, which illustrate the appropriate portion of the Work; showing fabrication, layout, setting or erection details, as specified in the appropriate Sections.
- 2.2 Identify content of shop drawings by the .pdf file name as specified above.
- 2.3 Identify details by reference to sheet and detail numbers shown on the Contract Drawings.
- 2.4 Drawing Format Submissions:
 - .1 Digital files in .pdf format.
 - .2 Upon return to the Contractor of reviewed digital submissions, the Contractor shall be responsible for printing and distribution of reviewed submissions to the appropriate Subcontractors and affected parties.
 - .3 Location (room number, etc).
- 2.5 Arrange for the preparation of Shop Drawings as called for in the Contract Documents or as may be reasonably requested by the Consultant. The Contractor and each Subcontractor shall operate as experts in their respective fields and all Shop Drawings and samples shall conform to the requirements of the Contract Documents.
- 2.6 The term "Shop Drawings" means drawings, diagrams, schematics, illustrations, schedules, performance charts, brochures and other data which are required to illustrate

details of the Work.

- 2.7 In addition to Shop Drawings specified in the specification sections, submit Shop Drawings required by jurisdictional authorities in accordance with their requirements.
- 2.8 Shop Drawings for openings, sleeving and conduit:
- .1 Prior to preparation of Shop Drawings, coordinate sizes of all structural openings and sleeves with respective fabricators for mechanical ducting. Adjustments to the opening sizes indicated on the Contract Drawings shall not be made without the approval of the Consultant.
 - .2 Prior to detailing structural reinforcement on Shop Drawings, arrange for the Structural Engineer to review formed holes, recesses and sleeving. Completely dimension openings, recesses and sleeves and relate to appropriate grid line(s) and elevation(s).
 - .3 Prior to forming of the structure, arrange for the preparation of Shop Drawings for review by the Consultant showing embedded conduit to be cast within the structure. Shop Drawings shall include conduit from all sources.
- 2.9 Shop Drawings shall indicate the following minimum criteria and any additional criteria indicated in the individual specification sections requiring Shop Drawings:
- .1 Clear and obvious notes of any proposed changes from the Contract Documents.
 - .2 Fabrication and erection dimensions.
 - .3 Provisions for allowable construction tolerances and deflections provided for live loading.
 - .4 Details to indicate construction arrangements of the parts and their connections, and interconnections with other work.
 - .5 Location and type of anchors and exposed fastenings.
 - .6 Materials, physical dimensions including thicknesses, and finishes.
 - .7 Descriptive names of equipment.
 - .8 Mechanical and electrical characteristics where applicable
 - .9 Information to verify that superimposed loads will not affect function, appearance, and safety of the work detailed as well as of interconnection work.
 - .10 Assumed design loadings, and dimensions and material specifications for load-bearing members.
 - .11 Include in Shop Drawing submissions detailed information, templates, and installation instructions required for incorporation and connection of the Work.

- .12 Before submitting to the Consultant, review all Shop Drawings to verify that the Products illustrated therein conform to the Contract Documents. By this review, the Contractor agrees that it has determined and verified all field dimensions, field construction criteria, materials, catalogue numbers and similar data and that it has checked and coordinated each Shop Drawing with the requirements of the Work and of the Contract Documents. The Contractor's review of each Shop Drawing shall be indicated by stamp, date and signature of a qualified person possessing the appropriate authorization from the Contractor.
- .13 Be responsible for dimensions, confirmed at the Site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the Work of all subtrades.
- .14 Submit Shop Drawings for the Consultant's review with reasonable promptness and in orderly sequence so as to cause no delay in the Work nor in the work of Other Contractors. At the time of submission, notify the Consultant in writing of any deviations in the Shop Drawings from the requirements of the Contract Documents. The Contractor will be held responsible for changes made from the Contract Documents which are not indicated or otherwise communicated in writing with the submission.
- .15 Drawings submitted by the Contractor as required herein are the property of the Owner who may use and duplicate such drawings where required in association with the Work.
- .16 Submit Shop Drawings signed and sealed by a licensed Professional Engineer registered in the place of the Work where indicated in individual Sections.
- .17 Shop Drawings shall have distinct, uniform letters, numerals and line thicknesses that will ensure the production of clear legible prints at original as well as reduced size.
- .18 Provide submissions in electronic Portable Document Format (PDF) format delivered via electronic means as directed by the Consultant.
- .19 Dimensions and designations of elements shall be shown in the same system of measurement used on the applicable Contract Drawings.
- .20 The Consultant reserves the right to refuse acceptance of drawing submissions not meeting the above requirements.
- .21 The Consultant's review will be for conformity to the design concept and for general arrangement only and such review shall not relieve the Contractor of responsibility for errors or omissions in the Shop Drawings or of responsibility for meeting all requirements of the Contract Documents unless a deviation on the Shop Drawings has been approved in writing by the Consultant. Review does not mean that Consultant approves detail inherent in Shop Drawings, responsibility which shall remain with Contractor submitting same.
- .22 The Contractor shall make any changes in Shop Drawings which the Consultant may require consistent with the Contract Documents and re-submit unless otherwise directed

by the Consultant. When re-submitting the Shop Drawings, the Contractor shall notify the Consultant in writing of any revisions other than those requested by the Consultant.

.23 Only drawings noted for revision and resubmission need be resubmitted.

.24 File one copy of each submitted Shop Drawing at the Site.

2.10 Product Data:

.1 Certain specification Sections specify that manufacturer's standard schematic drawings, catalogue sheets, illustrations and other standard descriptive data will be accepted in lieu of shop drawings.

.2 The above will be accepted only if they conform to the following:

- .1 Delete information which is not applicable to project
- .2 Supplement standard information to provide additional information applicable to project
- .3 Show dimensions and clearances required
- .4 Show performance characteristics and capacities
- .5 Show wiring diagrams (where applicable) and controls

.3 Submit as .pdf files, named as specified for shop drawings.

3 SHOP DRAWINGS REVIEW

3.1 The review of shop drawings by the Consultant is for the sole purpose of ascertaining conformance with the general concept. This review shall not mean that the Consultant approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of responsibility for errors or omissions in the shop drawings or of responsibility for meeting all requirements of the construction and contract documents.

3.2 Without restricting the generality of the foregoing, the Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all subtrades.

4 SAMPLES AND MOCK-UPS

4.1 Before delivery of Products to the Site, submit samples of Products as specified or as requested by the Consultant. Label samples as to origin and intended use in the Work and in accordance with the requirements of the Specification Sections. Samples must represent physical examples to illustrate materials, equipment or work quality and to establish standards by which completed Work is judged.

4.2 Ensure samples are of sufficient size and quantity, if not already specified, to illustrate:

- .1 The quality and functional characteristics of Products, including integrally related parts and attachment devices.
- .2 The full range of colours available.
- 4.3 Notify the Consultant in writing, at time of submission, of any deviations in samples from requirements of the Contract Documents, and state the reasons for such deviations.
- 4.4 Identify samples with Project name, Contract number, date, Contractor's name, number and description.
- 4.5 If samples are not acceptable, both samples will be returned. If samples are acceptable, one sample will be so indicated and returned. Be responsible for the cost of samples that are not accepted and for resubmission of samples.
- 4.6 Acceptable samples shall serve as a model against which the products incorporated in the work shall be judged.
- 4.7 Each Product incorporated in the Work shall be precisely the same in all details as the acceptable sample.
- 4.8 Should there be any change to the accepted sample, submit in writing for approval of the revised characteristics and resubmit samples of the Product for approval if requested.
- 4.9 When samples are very large, require assembly, or require evaluation at the Site, they may only be delivered to the Site with approval and as directed.
- 4.10 Construct field samples and mock-ups at locations acceptable to the Consultant.
- 4.11 Construct each sample or mock-up complete, including work of all trades required to finish work.
- 4.12 Reviewed samples or mock-ups will become the standards of workmanship and material against which installed work will be checked on the project.

5 COORDINATION OF SUBMISSIONS

- 5.1 Review and stamp shop drawings, product data and samples prior to submission.
- 5.2 Verify:
 - .1 Field measurements.
 - .2 Field construction criteria.
 - .3 Catalogue numbers and similar data.
- 5.3 Coordinate each submission with the requirements of the Work and the Contract Documents. Individual shop drawings will not be reviewed until all related drawings are available.

- 5.4 The Contractor's responsibility for errors and omissions in submission is not relieved by the Consultant's review of submittals.
- 5.5 The Contractor's responsibility for deviations in submission from the requirements of the Contract Documents is not relieved by the Consultant's review of the submission, unless the Consultant gives written acceptance of specified deviations.
- 5.6 Notify the Consultant, in writing at the time of submission, of deviations from the requirements of the Contract Documents.
- 5.7 After the Consultant's review, the .pdf file will be returned to the Contractor who shall distribute copies.
- 5.8 Originators preparing more than one submission, shall prepare a list of all shop drawings, complete with submission dates to the Consultant. Include this list with the first submission.

6 SUBMISSION REQUIREMENTS

- 6.1 Schedule submissions at least twenty 15 working days before the dates reviewed submissions will be needed.
- 6.2 Accompany each electronic submission with an email, titled as specified above.
- 6.3 Submissions shall include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name of:
 - .1 Contractor
 - .2 Subcontractor
 - .3 Supplier
 - .4 Manufacturer
 - .5 Separate detailer when pertinent
 - .4 Identification of product or material.
 - .5 Relation to adjacent structure or materials.
 - .6 Field dimensions, clearly identified as such.
 - .7 Specification section number.
 - .8 Applicable standards, such as CSA or CGSB numbers.
 - .9 Where applicable, the code used in the Contract Documents to identify the product

- .10 Originator's stamp and signature, certifying review of submission, verification of field measurements and compliance with the Contract Documents.
 - .11 Contractor's stamp and signature, certifying review of submission.
 - .12 Professional engineer's stamp and signature, where specific sections of the specification so direct. Note that drawings will not be reviewed unless the Professional Engineer's stamp and signature is present.
 - .13 CSA/CGSB/ASTM or other conformance certificates where applicable.
- 6.4 The Contractor's stamp and signature, certifying review of the Submission shall be interpreted to mean that the Contractor has reviewed the drawings and coordinated them with the work of other trades. Drawings which have not been so reviewed and coordinated by the Contractor will be returned for resubmission before Consultant review will be undertaken.

7 REQUESTS FOR INFORMATION (RFI)

- 7.1 All RFIs must be submitted in PDF digital format. Each RFI shall address a single subject only. **RFIs submitted as plain text in the body of an email will not be accepted or reviewed.** This requirement is intended to ensure clarity, consistency, and proper documentation. Non-compliant RFIs will be returned to the sender without review.
- 7.2 Name each RFI file with the project acronym (FIFAEAST), RFI, the sequential number, and the Subject of the RFI. i.e.: **FIFAEAST–RFI-01-TileColour**
- 7.3 Title emails sending RFI's the same as the file name (i.e. **FIFAEAST–RFI-01-TileColour**).

8 SUBSTITUTIONS

- 8.1 Specific products establish a standard of acceptance. Unless substitutions are excluded in the individual Specification Sections, equivalent products by other manufacturers are acceptable as substitutions, provided the properties and compliances of the substitutions meet or exceed the properties and compliances of the specified products in all respects and that items exposed to sight are of the same appearance as the specified items.
- 8.2 Requests for substitution of alternative products to those described in the Bid Documents, shall be submitted in writing no less than ten (10) days before the bid closing date.
- 8.3 A request shall include the following:
- .1 A description of the proposed substitution.
 - .2 A direct comparison between the properties and compliances of the specified product(s) with the properties and compliances of the proposed substitution, arranged in tabular form, in the same sequence as specified in the applicable specification section or in the sequence listed in the specified manufacturer's published literature, as appropriate.

- .3 Country of manufacture.
 - .4 Shop drawings, product data and certified test results attesting to the proposed material or product equivalence.
 - .5 A list of no less than five (5) projects of comparable size and complexity, where the proposed substitution has been used in a similar application in Canada, including the name and current telephone number of the Prime Consultant for each project.
- 8.4 The burden of proof is on the Bidder. In the event that the Consultant/Owner deems the provided information to be inadequate, the request may be rejected.
- 8.5 A request constitutes a representation that the Bidder:
- .1 Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.
 - .2 Will provide the same warranty for the Substitution, as for the specified Product.
 - .3 Will coordinate installation and make the required changes for the Work to be completed with no additional cost to the Owner.
 - .4 Assumes full responsibility that the substitute products will not exceed the space requirements allocated on the drawings.
 - .5 Waives claims for additional costs or time extension which may subsequently become apparent.
 - .6 Will reimburse the Owner for the cost of review or redesign services associated with re-approval by authorities.
- 8.6 Where the terms "or equal", "or equivalent" or terms of similar meaning are used in the specifications, this shall not release/relieve the Subcontractor from the responsibility to follow the stated procedures for approval of substitutions specified herein.
- 8.7 No substitutions will be permitted after award of the Contract, except under the following circumstances:
- .1 If a material or product becomes unavailable through no fault of the Contractor.
 - .2 If the delivery date of the specified products unduly delays the completion of the Contract.
 - .3 Alternative products to those specified, which are brought to the attention of and considered by the Consultant/Owner as equivalent and, which will result in a credit to the Contract Sum.
- 8.8 Regardless of the above, no substitutions will be permitted without the prior written approval of the Consultant/Owner.

9 CERTIFICATES

- 9.1 Submit certificates that are required by authorities having jurisdiction or that are requested in the applicable specification sections.
- 9.2 Clearly show on each certification the name and location of the Work, name and address of Contractor, quantity and date of shipment and delivery and name of certifying company.
- 9.3 Certificates shall verify that Products and/or methods meet the specified requirements and shall include test reports of testing laboratories approved to validate certificates.
- 9.4 Submit certificates in duplicate and signed by an authorized representative of the certifying company.

10 CERTIFICATION OF SKILLED TRADES WORKERS

- 10.1 Provide certificates, at the request of the Consultant, to establish qualifications of personnel employed on the Work where such certification is required by authorities having jurisdiction, by the Consultant or by the Contract Documents.

11 EXTENDED WARRANTIES

- 11.1 Submit extended warranties as requested in sections of the Specifications showing title and address of Contract, warranty commencement date and duration of warranty.
- 11.2 Extended warranties shall commence on termination of the standard warranty specified in the conditions of the contract and shall be an extension of these provisions. Clearly indicate what is being warranted and what remedial action is to be taken under the warranty. Ensure warranty bears the signature and seal of the Contractor.
- 11.3 Submit each extended warranty on a form that is acceptable to the Owner and Consultant.

12 INSPECTION AND TEST REPORTS

- 12.1 Submit inspection and test reports as specified in the Sections of the specifications for “Source Quality Control” and “Field Quality Control” within 2 working days of inspection or testing. If immediate action is required by the Contractor or Consultant inform the Consultant immediately and submit inspection and testing report within one working day.
- 12.2 Submit report with certificates of compliance indicating but not limited to the following:
 - .1 Project name and number.
 - .2 Date of inspection or test and date report is issued.
 - .3 Name and address of inspection and testing company.
 - .4 Name and signature of inspector or tester.

- .5 Identification of Product and Specification Section covering inspected or tested work.
 - .6 Specified requirements for which the inspection or testing was performed and results of inspections or tests.
 - .7 Location of inspection or from which tested material was derived.
 - .8 Overview of inspection and testing methods and procedures.
 - .9 Remarks and observations on compliance with Contract Documents.
- 12.3 Inspection and test reports shall be signed by a responsible officer for the inspection and testing company.
- 13 **PROGRESS PHOTOGRAPHS**
- 13.1 Concurrently with monthly application for payment submit digital photos illustrating the progress of the Work as follows:
- .1 A minimum of 50 photos that best illustrate the progress on the site.
 - .2 Photos shall be in focus and properly illuminated; view shall be unobstructed.
 - .3 The photos shall either have an accurate date-stamp present in the photo or be numbered and dated in the digital filename.
- 13.2 **PROGRESS REPORTS**
- .1 Prepare a monthly progress report current to the last Friday of each month. The report shall indicate the period covered and include but not be limited to the following:
 - .1 Executive Summary
 - .2 Areas of Concern/Action Required
 - .3 Work Accomplished This Period
 - .4 Work Planned Next Period
 - .5 Schedule Status
 - .6 Budget Status
 - .7 Status of Submittals
 - .8 Quality Control
 - .9 Contract Changes
 - .10 Outstanding Actions
 - .2 Submit the monthly progress report such that it is received by the Consultant no later than the Wednesday following the last Friday of the month, regardless of whether or not the Monday is a public holiday.

13.3 OPERATION AND MAINTENANCE MANUALS

- .1 Submit Operation and Maintenance Manuals in accordance with Section 01 78 23.

13.4 RECORD DOCUMENTS

- .1 Submit record documents in accordance with Section 01 78 39.

END OF SECTION

1 GENERAL

- 1.1 Provide labour, Products, equipment, services tools and supervision necessary for submittals. Make submittals specified in this Section to Consultant unless otherwise specified.

2 REFERENCES

- 2.1 South Coast Air Quality Management District (SCAQMD)

- .1 Amendment to South Coast Rule 1168, VOC Limits
- .2 Rule 1113, VOC Limits

- 2.2 CDPH Standard Method v1.2–2017

- .1 ISO Guide 65
- .2 ISO 16000 parts 3, 6, 7, 11
- .3 Canadian VOC Concentration Limits for Architectural Coatings 2009
- .4 CARB 93120 ATCM
- .5 ANSI/BIFMA M7.1 Standard Test Method for Determining VOC Emissions from office Furniture Systems, Components and Seating
- .6 ANSI/BIFMA e3–2011 Furniture Sustainability Standard

2.3 DEFINITIONS

- .1 Acrylonitrile-butadiene-styrene (ABS): A type of plastic produced by the chemical reaction of acrylonitrile, butadiene, and styrene monomers, often identified by its ABS marking.
- .2 Adhesive: A material designed to bond surfaces together through attachment. This category includes bonding primers and adhesive primers for various materials like plastics.
- .3 Adhesive Primer for Plastic: A preparatory material applied to plastic surfaces to enhance the adhesion of subsequent adhesives.
- .4 Anti-corrosive / Anti-rust Paints: Protective coatings formulated to prevent corrosion on ferrous metal surfaces.
- .5 Architectural Nonporous Sealant Primer: A primer designed for sealants used on nonporous materials.
- .6 Architectural Porous Sealant Primer: A primer specifically for sealants applied to porous materials.
- .7 Architectural Sealant: A sealing material applied to architectural elements like ducting, railings, cabinetry, or fixtures such as sinks and windows.

- .8 Bond Breakers: Materials applied between concrete layers to prevent the top layer from adhering to the substrate below.
- .9 Ceramic Tile Adhesive: Adhesives intended for affixing ceramic or porcelain tiles.
- .10 Clear Brushing Lacquer: A clear finish for wood, excluding lacquer sanding sealers, that forms a protective film as it dries through solvent evaporation.
- .11 Clear Wood Finishes: Transparent or semi-transparent finishes, such as varnishes and lacquers, used to enhance and protect wood surfaces.
- .12 Chlorinated Polyvinyl Chloride (CPVC): A polymer containing 67% chlorine, often marked as CPVC, used in various applications.
- .13 Coating: A substance applied to surfaces to protect, beautify, or serve as a barrier.
- .14 Concrete-Curing Compounds: Coatings used on newly poured concrete to slow water evaporation.
- .15 Contact Adhesive: Adhesives applied to two surfaces, allowed to dry, then joined under pressure for bonding.
- .16 Corner Guard Adhesive: Adhesive used to attach corner guards, typically made of vinyl or rubber, to wall edges.
- .17 Cove Base Adhesive: Adhesive for installing cove base materials along walls, commonly made from vinyl or rubber.
- .18 Drywall Adhesive: Adhesive used for securing gypsum drywall to studs or solid surfaces.
- .19 Dry-Fog Coatings: Specially designed coatings for spray application, drying before reaching other surfaces as overspray.
- .20 Faux Finishing Coatings: Decorative glazes used to mimic textures like wood grain or marble or to create artistic effects.
- .21 Flat Paints and Coatings: Paints or coatings with low gloss levels, below 15 on an 85-degree meter or below 5 on a 60-degree meter.
- .22 Fiberglass Substrate Adhesive: Adhesive governed by specific VOC limits when applied to fiberglass substrates.
- .23 Floor Coatings: Protective coatings designed for floors, including both opaque and clear varieties for concrete surfaces.
- .24 Graphic Arts (Sign) Coatings: Hand-applied paints, such as lettering enamels and poster colors, used for artistic or signage purposes.
- .25 High-Temperature Industrial Maintenance Coatings: Coatings made for surfaces exposed to temperatures exceeding 400°F.
- .26 Indoor Adhesive, Sealant, or Sealant Primer: Products used inside a building's weatherproofing system during application.
- .27 Indoor Paints or Coating Products: Paints or coatings applied within the building's weatherproofing system.
- .28 Industrial Maintenance Coatings: Coatings designed for substrates requiring enhanced durability against chemicals, moisture, or high temperatures.
- .29 Interior of the Building: Areas within a building's weatherproof envelope, encompassing materials and spaces inside.
- .30 Lacquers: Wood finishes that dry through solvent evaporation, including sanding sealers and pigmented varieties.
- .31 Low-Solids Coatings: Coatings with minimal solids content, measured in VOC per litre, including water.

- .32 Magnesite Cement Coatings: Coatings for protecting magnesite cement decking from water erosion.
- .33 Mastic Coatings: Thick coatings used to conceal imperfections or fill gaps, applied in layers at least 10 mils thick.
- .34 Metal to Metal Substrate: Adhesives governed by specific VOC limits when applied between metal surfaces.
- .35 Multi-purpose Construction Adhesive: Adhesive for diverse materials like drywall, subflooring, and ceiling tiles.
- .36 Non-flat Paints and Coatings: Paints with gloss levels above 5 on a 60-degree meter and above 15 on an 85-degree meter.
- .37 Nonporous Sealant: Sealants for surfaces that do not absorb or discharge fluids, such as plastic or metal.
- .38 Off-gassing: Emission of VOCs from materials like synthetic or natural products.
- .39 Paint: A liquid or semi-liquid substance that forms a protective or decorative film upon drying.
- .40 Panel Adhesive: Adhesive for mounting panels like plywood or fiberglass-reinforced plastic to surfaces.
- .41 Plastic Foam Substrate Adhesives: Adhesives intended for use with plastic foam substrates, regulated by applicable VOC limits when no other specific definitions apply.
- .42 Plastic Cement Welding: A bonding method using solvent-based adhesives to dissolve and bond plastic surfaces, excluding ABS, CPVC, and PVC.
- .43 Pre-treatment Wash Primers: Primers containing at least 0.5% acid by weight, applied directly to bare metal to achieve surface etching.
- .44 Porcelain Tile Adhesive: Adhesives formulated for installing ceramic or porcelain tiles.
- .45 Porous Materials: Materials like wood or fabric with microscopic openings that allow fluids to be absorbed or discharged.
- .46 Porous Material Substrate Adhesive (except wood): Adhesives regulated by VOC limits for porous materials when specific definitions do not apply.
- .47 Primer: A preparatory coating applied to a surface to improve the adhesion of subsequent layers.
- .48 Polyvinyl Chloride (PVC): A plastic polymer containing 57% chlorine, commonly identified by PVC markings.
- .49 Quick-Dry Enamels: High-gloss coatings that set to touch within two hours, dry hard in eight hours, and become tack-free within four hours.
- .50 Quick-Dry Primers: Primers designed to dry to touch in 30 minutes and allow recoating within two hours.
- .51 Rubber Flooring Adhesive: Adhesives used for installing rubber flooring in sheet or tile form.
- .52 Sanding Sealers: Clear coatings applied to bare wood for sanding and sealing before applying additional coatings.
- .53 Sealant: A material with adhesive properties designed to fill or waterproof gaps and joints between surfaces, including caulks and primers.
- .54 Sealant Primer: A primer applied to a surface before using a sealant to improve adhesion.

- .55 Sealers: Coatings used to block materials from penetrating or leaching out of substrates or to protect subsequent coatings from substrate materials.
- .56 Sheet-applied Rubber Lining Operation: The manual application of rubber sheets to metal or plastic substrates for corrosion or abrasion resistance.
- .57 Shellac: Quick-drying, resin-based coatings derived from lac insect secretions, used for priming, sealing, and wood finishing (excluding floors).
- .58 Special Purpose Contact Adhesive: Adhesives for specialized applications involving substrates like melamine board, metal, Teflon, or ultra-high molecular weight polyethylene.
- .59 Specialty Primers: Primers designed to seal surfaces affected by fire, smoke, or water damage.
- .60 Stains: Coatings that alter a surface's color without obscuring its grain or texture.
- .61 Structural Glazing Adhesive: Adhesives used for attaching structural elements such as glass, metal, or stone to building frames.
- .62 Structural Wood Member Adhesive: Adhesives used for constructing load-bearing wood components like beams and trusses.
- .63 Subfloor Adhesive: Adhesives for securing subflooring materials over joists.
- .64 Substrate-Specific Applications: VOC limits applicable to adhesives or primers used on substrates without specific categorization elsewhere.
- .65 Undercoaters: Coatings that create a smooth base layer for subsequent finishes.
- .66 Varnishes: Transparent finishes for wood that dry through chemical reaction, providing durability and protection.
- .67 VCT (Vinyl Composition Tile): Flooring material made from thermoplastic resins, fillers, and pigments.
- .68 Volatile Organic Compounds (VOCs): Carbon-based compounds that vaporize at room temperature and participate in photochemical reactions (excluding carbon monoxide, carbon dioxide, and similar inert compounds).
- .69 Waterproofing Concrete / Masonry Sealers: Sealers that protect concrete and masonry from water, alkalis, acids, ultraviolet light, and stains.
- .70 Wood Preservatives: Coatings designed to protect wood from decay or insect damage through the addition of specialized chemicals.
- .71 Wood Substrate Adhesive: Adhesives regulated by VOC limits when used with wood substrates, provided no specific definitions apply.
- .72 Waterproofing Sealers: Coatings primarily formulated to prevent water penetration into porous substrates.
- .73 Weatherproofing System: The barrier that shields a building from external environmental conditions such as wind and water, typically comprising the air barrier within wall and roof assemblies.
- .74 Wood Flooring Adhesive: Adhesives formulated for installing wood flooring, including parquet tiles, planks, or strip-wood flooring.
- .75 Zinc-Rich IM Coatings: Primers with at least 65% metallic zinc powder by weight, used on metal substrates for enhanced corrosion resistance.

2.4 SUBMITTALS

- .1 Submit manufacturer letters, technical data sheets and/or MSDS (Material Safety

Data Sheets, providing the following information:

- .1 VOC contents in g/L format
- .2 Description of applications and intended uses
- .3 Confirmation that products are compliant with the requirements listed within the product section of this specification.

3 PRODUCTS

- 3.1 All adhesives, sealants, paints, coatings, ceiling materials, wall materials, flooring materials, composite wood, and furniture installed on the interior side of the building (i.e., within the weatherproofing system and applied on-site) must adhere to the requirements outlined in this specification, regardless of the construction phase (including prior to building enclosure).
- 3.2 All insulation materials, whether for acoustic or thermal purposes and regardless of their location within the building, must comply with the requirements of this specification during all construction phases, including prior to building enclosure.
- 3.3 If there is uncertainty about whether a product must meet the requirements of this specification section, it must be submitted for review by the consultant to provide clarity and direction.
- 3.4 Insulation, Ceilings, Flooring, and Walls
 - .1 All insulation products, whether used on the building's interior or exterior, must comply with these requirements, with the exception of ductwork insulation, both internal and external.
 - .2 Ceilings encompass overhead structural components (finished, unfinished, or exposed), direct-applied systems, suspended systems (e.g., canopies or clouds), and glazed skylights. Examples include painted drywall, plaster, acoustical suspension systems, and specialty systems made from materials like plastic, metal, or wood. Structural components that are painted or otherwise finished also fall under this category. When there is ambiguity between classifying an element as a wall or ceiling, the project team may decide based on practicality.
 - .3 Flooring materials include finished surfaces such as subflooring, fluid-applied adhesives, troweled grouts (for full spreads only), engineered wood, resilient flooring, carpeting, and mineral-based tiles.
 - .4 Wall materials refer to generally vertical structural elements, whether exposed, finished, or unfinished. This includes finishes, interior columns, exterior and interior glazing, doors, partial-height partitions (e.g., bulkheads, transoms, pony walls, knee walls), architectural woodwork, cabinetry, and floor-to-ceiling movable partitions.

Ambiguities between wall and ceiling classification may be resolved by the project team as deemed appropriate.

- .5 Insulation, ceiling, flooring, and wall products must be tested for compliance based on the California Department of Public Health (CDPH) Standard Method v1.2–2017, using the relevant exposure scenario (default: private office scenario). Manufacturer or third-party certification must state the testing scenario used to verify compliance. For wet-applied products, claims must specify the applied mass per surface area. Additionally, the compliance documentation must indicate total VOC concentrations at 14 days (336 hours), categorized as $\leq 0.5 \text{ mg/m}^3$, $0.5\text{--}5.0 \text{ mg/m}^3$, or $\geq 5.0 \text{ mg/m}^3$.
- 3.5 Composite Wood Products
- .1 Composite wood is defined as a material comprising wood or plant fibers/particles bonded using synthetic resins or adhesives. Examples include particleboard, medium-density fiberboard (MDF), plywood, oriented strand board (OSB), wheatboard, and strawboard.
 - .2 Composite wood products must meet the California Air Resources Board (CARB) Airborne Toxic Control Measure (ATCM) for ultra-low-emitting formaldehyde (ULEF) resins or no-added formaldehyde resins.
 - .3 Architectural millwork that is salvaged or reused and over one year old at the time of occupancy is considered compliant, provided that any site-applied finishes such as paints, adhesives, or sealants meet the specification requirements.
- 3.6 Adhesives, sealants, paints, and coatings applied inside the weatherproofing system must meet the requirements specified herein.
- 3.7 Sealants are materials formulated with adhesive properties, primarily for filling, sealing, or waterproofing gaps and joints between surfaces. This includes primers and caulks.
- 3.8 Adhesives, sealants, paints, and coatings must be tested and verified for compliance based on the CDPH Standard Method v1.2–2017 using the applicable exposure scenario. The private office scenario serves as the default. Documentation must include the exposure scenario and applied mass per surface area for wet-applied products. Compliance must specify total VOC concentrations at 14 days as $\leq 0.5 \text{ mg/m}^3$, $0.5\text{--}5.0 \text{ mg/m}^3$, or $\geq 5.0 \text{ mg/m}^3$.
- 3.9 In addition to meeting CDPH Standard Method v1.2–2017 requirements, adhesives, sealants, paints, and coatings must comply with the VOC limits specified in the accompanying tables.
- 3.10 Definitions provided in this specification are intended to assist in categorizing the products used in this project.

- 3.11 Products that fall under any of the definitions in this specification must be submitted for review.
- 3.12 If there is ambiguity regarding a product's classification or whether it must be submitted for review, it should be referred to the consultant for guidance.
- 3.13 Product compliance shall be measured in grams per liter (g/L).
- 3.14 When calculating VOC content, pigments are not required to be included.
- 3.15 The methods used to determine VOC content are not limited to those specified here, as long as they measure VOC in g/L, excluding water.
- 3.16 Test methods must include VOC measurements expressed in g/L, excluding water content.
- 3.17 VOC Maximum Limits for Adhesives, Sealants, Paints and Costings:
 - .1 Adhesives
 - .1 Carpet Adhesives: 50
 - .2 Carpet Pad Adhesives: 50
 - .3 Wood Flooring Adhesives: 100
 - .4 Rubber Floor Adhesives: 60
 - .5 Subfloor Adhesives: 50
 - .6 Porcelain / Ceramic Tile Adhesives: 65
 - .7 VCT & Asphalt Tile Adhesives: 50
 - .8 Drywall & Panel Adhesives: 50
 - .9 Cove Base Adhesives: 50
 - .10 Corner Guard Adhesives: 50
 - .11 Multipurpose Construction Adhesives: 70
 - .12 Structural Glazing Adhesives / Sealants: 100
 - .13 PVC Welding: 510
 - .14 CPVC Welding: 490
 - .15 ABS Welding: 325
 - .16 Plastic Cement Welding: 250
 - .17 Adhesive Primer for Plastic: 550
 - .18 Contact Adhesive: 80
 - .19 Special Purpose Contact Adhesive: 250
 - .20 Structural Wood Member Adhesive: 140
 - .21 Sheet Applied Rubber Lining Operations: 850
 - .22 Top and Trim Adhesive: 250
 - .2 Sealants
 - .1 Architectural Sealant: 250
 - .2 Structural Glazing Adhesive / Sealant: 100
 - .3 Sealant Primer - Non-Porous: 250
 - .4 Sealant Primer - Porous: 775
 - .5 Roadway Sealant: 250

- .3 Substrate Specific Sealants (Note: Substrate-specific limits apply only for materials not governed in other sections of this table.)
 - .1 Metal to Metal: 30
 - .2 Plastic Foams: 50
 - .3 Porous Material (Except Wood): 50
 - .4 Wood Flooring Adhesives: 30
 - .5 Fiberglass: 80
- .4 Paints and Coatings
 - .1 Metallic Pigmented Coating: 150
 - .2 Extreme High Durability Coating: 800
 - .3 Faux Finish: 350
 - .4 Shellac, Clear: 730
 - .5 Shellac, Opaque: 550
 - .6 Clear Lacquer for Wood: 275
 - .7 Other Lacquer: 275
 - .8 Oil Varnish for Wood: 275
 - .9 Any Other Varnish: 350
 - .10 Wood Conditioners: 100
 - .11 Wood Preservatives: 350
 - .12 Sanding Sealer: 275
 - .13 Specialty Primer, Sealer, or Coating: 100
 - .14 Waterproofing Sealer for Concrete or Masonry: 100
 - .15 Any Other Waterproofing Sealer: 100
 - .16 Any Other Primer, Sealer, or Undercoater: 100
 - .17 Quick-Dry High-Gloss Enamel: 250
 - .18 Recycled Coating: 250
 - .19 Any Flat Coating Not Listed Above: 50
 - .20 Any Non-Flat Coating (Not High Gloss): 50
 - .21 Any High Gloss Coating: 150
- .5 Additional Paint and Coating VOC Limits
 - .1 Rust Preventative Coating: 100
 - .2 Stains: 250
 - .3 Floor Enamel, High Gloss: 100
 - .4 Any Other Opaque Floor Coating: 100
 - .5 Mastic Texture Coating: 100
 - .6 Fire Resistant Coating: 150
 - .7 Graphic Arts Coatings: 150
 - .8 Dry Fog Coating: 50
 - .9 Floor Coatings: 50
 - .10 Multi-Color Coatings: 250
 - .11 Magnesite Cement Coatings: 450
 - .12 Tile and Stone Sealer: 100
 - .13 Zinc Rich Primers: 100
 - .14 Industrial Maintenance Coatings: 100
 - .15 High Temp Industrial Maintenance Coatings: 420
 - .16 Roof Primers: 350

- .17 Bond Breaker: 350
- .18 Concrete Curing Compound: 100
- .19 Concrete Surface Retarder: 50
- .20 Form Release Compound: 250
- .21 Traffic Coating: 100

END OF SECTION

1 **CONSTRUCTOR**

- 1.1 For the purposes of the Contract, the term "Constructor", as defined in the Occupational Health and Safety Act, shall mean the Contractor who shall be responsible for ensuring that the provisions of the statutes, regulations and by-laws pertaining to the safe performance of the Work are to be observed. The "Constructor" shall submit the Notice of Project.
- 1.2 In the event of conflict between any of the provisions of Statutes, Regulations and By- laws, and other requirements of authorities, the most stringent provision applies.
- 1.3 the Contractor's representative shall be responsible for ensuring that the provisions of statutes, regulations and by-laws pertaining to safe performance of the Work and the work of Other Contractors and Owner's own forces working on the Site are observed and that the methods of performing the Work do not endanger the personnel employed thereon nor the general public, and are in accordance with the latest edition of the Occupational Health and Safety Act. Include on the Joint Health and Safety Committee representatives of Other Contractors working on Site.
- 1.4 Prior to the Contractor's representative being absent from the Site for an extended period during execution of the Work, the Contractor's representative will name, in writing to the Consultant, another person who is competent to assume these responsibilities. The Contractor shall advise the Consultant of change of the individual identified as the Contractor's representative.
- 1.5 At the discretion of the Consultant, the "Constructor" designation may be transferred to/from a Contractor at any time at no additional cost to the Owner.

2 **PROJECT RESPONSIBILITIES**

- 2.1 The Contractor's representative shall ensure that:
- 2.2 All measures and procedures prescribed by the following Acts and Regulations are carried out on Site:
- .1 The Occupational Health and Safety Act;
- .1 worker safety is given first priority in planning, pricing and performing the Work;
- .2 its officers and supervisory employees have a working knowledge of the duties of a "constructor and "employer" as defined by the Act and the provisions of the Regulations applicable to the Work, and a personal commitment to comply with them;

- .3 A copy of the most current version of the Act and the Regulations are available at the Contractor's office at the Place of Work, in the absence of an office, in possession of the supervisor responsible for the performance of the Work;
 - .4 workers employed to carry out the Work possess the knowledge, skills and protective devices required by law or recommended for use by a recognized industry association to allow them to work in safety;
 - .5 supervisory employees carry out their duties in a diligent and responsible manner with due consideration for the health and safety of the workers; and
 - .6 all Subcontractors and their employees are properly protected from injury while they are at the Place of Work.
- .2 The Regulations for Construction Projects;
 - .3 WHMIS Regulations;
 - .4 The Environmental Protection Act and regulations,
 - .5 All other legislation, regulations and standards as applicable.
- 2.3 Every employer and every worker performing Work on the Site must comply with the requirements referred to above.
- 2.4 Ensure that the health and safety of workers, employees of the Owner and the general public are protected in relation to the Work performed on the Site.
- 2.5 **WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS)**
- 2.6 Be familiar with and comply with WHMIS regulations.
- 2.7 Properly label controlled products. Provide proper warning labels and training at the Site.
- 2.8 Maintain on site for duration of Contract a hazardous materials log containing all required MSDS. Log shall be open for inspection by Owner, Consultant and all personnel on Site.
- 2.9 Provide copies of material safety data sheets (MSDS) for any controlled products prior to delivery to the Site.
- 2.10 Be responsible for all applicable requirements of the regulations.
- 2.11 Before commencing any Work on Site, attend the pre-construction meeting and provide the Consultant with a proposal as to how hazardous materials will be

stored and dispensed on Site. In addition, specifically outline the measures which will be undertaken to prevent damage or injury in the event of an accidental spill.

- 2.12 Provide "Handling Procedure for Hazardous Materials".

3 JOINT HEALTH AND SAFETY COMMITTEE

- 3.1 The Contractor shall be responsible for the establishment and operation of the Joint Health and Safety Committee as required by the Occupational Health and Safety Act.

4 DELIVERABLES

- 4.1 The Contractor shall deliver to the Consultant:

- .1 The Contractor's Occupational Health and Safety Policy.
- .2 The Contractor's safety program to implement the Occupational Health and Safety Policy for the Contract, which will effectively prevent and control accidents for the Contract.
- .3 A copy of all communications with, and including all orders by, the Ministry of Labour or other occupational health and safety enforcement authority.
- .4 A copy of all accident/injury investigation reports, not just the WSIB Form 7. Each report must contain a statement of actions that will be taken to prevent a recurrence.
- .5 A copy of all inspection reports made by the Contractor in compliance with the employer's responsibility under the Occupational Health and Safety Act.
- .6 A copy of all safety information pertaining to the Contract made and furnished by the Contractor's own "Safety Personnel" or outside consultants/advisers engaged for the purpose of inspecting the workplace for occupational health and safety.
- .7 A verification that all workers in the employ of the Contractor on Site, have had a WHMIS training or refresher course within the last twelve months.
- .8 A verification that all workers in the employ of the Contractor have had "Explosive Activated Tool Training" on the type of tools being used.
- .9 A verification that the instruction manuals are on Site for all tools and equipment being used.
- .10 A copy of the most recent workers compensation experience rating account, i.e.CAD-7, NEER, and/or an insurance carrier's experience rating account.

- .11 Statistical information for the purpose of determining injury frequency and severity rates (hours worked, first-aid injuries, medical aid injuries, lost time injuries, restricted workday injuries, near-miss accident/incident and significant occurrence data), in a timely manner as required by the Consultant.
 - .12 The immediate reporting to the Consultant of all instances that are defined in the Occupational Health and Safety Act as "Notices of Injuries" and "Occurrences" and any occasion that a worker exercises their "Right to Refuse Unsafe Work".
- 4.2 The Consultant reserves the right to require additional or amended deliverables pertaining to safety during the duration of the Work at no additional cost to the Owner.
- 4.3 Items specified above shall be delivered to the Consultant prior to the Contractor commencing Work on the Site.
- 5 **DUE DILIGENCE**
- 5.1 The Contractor acknowledges that it has read and understands the measures and procedures relating to occupational health and safety as prescribed above. The Contractor acknowledges and understands its duties as therein set out and hereby expressly undertakes and agrees to comply with all such requirements and standards in their entirety and at the Contractor's expense.
- 5.2 The Contractor further agrees to fully cooperate with all health and safety requirements, rules, regulations, standards and criteria set out in the Contract Documents, which agreement is in furtherance of the Contractor's duties and responsibilities under occupational health and safety legislation.
- 5.3 The Contractor agrees that if, in the opinion of the Consultant or Owner, the health and safety of a person or persons is endangered or the effective operation of the system put in place to ensure the health and safety of workers on the Site is not being implemented, the Consultant or Owner may take such action as it deems necessary and appropriate in the circumstances, including, without limitation, the following:
- .1 Require the Contractor to remedy the condition forthwith at its own expense;
 - .2 Require that the Site be shut down in whole or in part until such time as the condition has been remedied;
 - .3 Remedy the problem and the Owner shall back-charge the Contractor for the cost of such remedial work, together with an appropriate overhead factor as determined by the Owner in its sole discretion; and
 - .4 Terminate the Contract without further liability in the event the Contractor fails to comply with these provisions;

- .5 If a lien is registered, in respect to any monies held back, back-charged or assessed in accordance with these paragraphs, the Contractor shall consent to an order vacating such registration and shall indemnify the Owner for any and all loss, whereby direct or consequential which the Owner may sustain as a consequence of such registration

6 HEALTH AND SAFETY PLAN

- 6.1 Submit a project-specific health and safety policy and program during the preconstruction meeting. Promptly address requests from the Consultant or Owner for verification that the methods and procedures used to execute the Work are in compliance with applicable Acts and Regulations.
- 6.2 Collaborate with the Consultant and the Owner's designated representatives responsible for enforcing health and safety regulations during any investigations related to worker safety in the course of the Work. Assume responsibility for and indemnify the Owner against any additional costs incurred to complete the Work due to the Contractor's non-compliance with the Acts and Regulations.
- 6.3 Before starting the Work, provide a list of products regulated under the Workplace Hazardous Materials Information System (WHMIS) that will be used on the project, along with the associated Material Safety Data Sheets (MSDS). Ensure all containers for WHMIS-regulated products are appropriately labeled. Notify the Consultant in writing of any changes and submit updated Material Safety Data Sheets as required.

7 SITE SAFETY PERSONNEL

- 7.1 Designate an authorized representative to be present on-site whenever work is being conducted. This individual shall serve as the Health and Safety Coordinator for the project, acting on behalf of the Contractor to ensure adherence to the project-specific health and safety policy by all construction personnel. They will also be responsible for implementing any additional health and safety measures required.
- 7.2 Before construction begins, provide the Consultant with a list containing the names, addresses, positions, and contact numbers of the Contractor's representatives who are available to address any matters related to the Contract at all times.

END OF SECTION

1 GENERAL

- 1.1 Be responsible for inspection and testing as required by the Contract Documents, statutes, regulations, by-laws, standards or codes or any other jurisdictional authority. Give the Consultant timely notice of the readiness for inspection, date and time for such inspection for attendance by the Consultant.

2 FIRES

- 2.1 The lighting of fires and burning of waste materials on-site is strictly prohibited.

3 DISPOSAL OF WASTE

- 3.1 Do not bury waste or debris on the project site.
- 3.2 Waste or volatile substances, including mineral spirits, oil, or paint thinner, must not be discharged into waterways, storm drains, or sanitary sewers.
- 3.3 Hazardous waste and volatile materials must be disposed of in compliance with the regulations of the relevant authorities. Ensure that all disposal methods safeguard construction personnel, site visitors, and the general public from potential hazards.

4 DRAINAGE

- 4.1 Provide temporary drainage and pumping to keep excavations and the site free of water accumulation.
- 4.2 Avoid discharging water with suspended solids into waterways, sewers, or drainage systems.
- 4.3 Manage the runoff or disposal of water containing suspended solids or harmful substances in line with local regulations.
- 4.4 The Contractor is responsible for obtaining all necessary permits for water pumping activities (e.g., Permit to Take Water).

5 POLLUTION CONTROL

- 5.1 Ensure that emissions from equipment and machinery comply with the standards set by local authorities.
- 5.2 Prevent contamination of the air beyond the immediate work area by using temporary enclosures for activities such as sandblasting.
- 5.3 Cover or moisten dry materials and waste to control the spread of dust and debris. Implement dust control measures for temporary roads as needed.

END OF SECTION

1 **GENERAL**

- 1.1 Be responsible for inspection and testing as required by the Contract Documents, statutes, regulations, by-laws, standards or codes or any other jurisdictional authority. Give the Consultant timely notice of the readiness for inspection, date and time for such inspection for attendance by the Consultant.
- 1.2 Verify by certification that specified products meet the requirements of reference standards specified in the applicable specification sections.
- 1.3 Conduct testing, balancing and adjusting of equipment and systems specified in applicable mechanical and electrical specifications sections by independent testing company.

2 **CANADA GREEN BUILDING COUNCIL's (CaGBC) Zero Carbon Building – Design ZERO CARBON BUILDING - DESIGN REQUIREMENTS**

- 2.1 CAGBC Zero Carbon Building - Design requirements shall apply to all relevant sections and work for this project, whether specifically indicated or not.
- 2.2 Compliance with requirements needed to obtain CAGBC Zero Carbon Building - Design certification will be used as one criterion to evaluate requests for substitutions or alternates.

3 **INSPECTION AND TESTING BY THE OWNER**

- 3.1 The Consultant, on behalf of the Owner may appoint an independent inspection and testing company to carry out inspection and testing of the Work for conformance to the Contract Documents. Such costs for inspection and testing will be paid by the Owner. However, any additional inspection and testing due to non-conformance to the Contract Documents shall be at the Contractor's expense.
- 3.2 Inspections and testing by the independent inspection an testing company will be promptly made. Uncover for examination any Work covered up prior to inspection or without approval of the Consultant. Make good such Work at no cost to the Owner.
- 3.3 The Owner may inspect and test Products during manufacture, fabrication, shop testing, installation, construction and testing phases of the Contract. The Consultant will ascertain the quantity and quality of testing to be performed. Inspection and testing may be performed at the place of manufacture/fabrication, storage, or at the Site as designated by the Consultant. Where inspection and testing is done either during manufacture, fabrication, or at Site, ensure that proper facilities and assistance are provided.

4 **INDEPENDENT INSPECTION AND TESTING AGENCIES**

- 4.1 Source and Field Quality Control specified in Other Sections:
- .1 This Section includes requirements for performance of inspection and testing specified under Source Quality Control and Field Quality Control in other Sections of the specifications.
- .2 Do not include in work of this Section responsibilities and procedures that relate solely to an inspection and testing company's functions that are specified in another Section which is paid for directly by the Owner.

5 **INSPECTION AND TESTING PROCEDURES**

- 5.1 Perform specified inspection and testing only in accordance with specified reference

- standards, or as otherwise approved.
- 5.2 Observe and report on compliance of the Work to requirements of Contract Documents.
- 5.3 Ensure that inspectors are on site or at fabricator's operations for full duration of critical operations, and as otherwise required to determine that the Work is being performed in accordance with the contract Documents.
- 5.4 Identify samples and sources of materials.
- 5.5 Review and report on progress of the work. Report on count of units fabricated and inspected at fabricator's operations.
- 5.6 Observe and report on conditions of significance to work in progress at time of inspection or at fabricator's operations. Include where applicable and if critical to the work in progress:
 - .1 Time and date of inspection.
 - .2 Temperature of air, materials, and adjacent surfaces.
 - .3 Humidity of air, and moisture content of materials and adjacent materials.
 - .4 Presence of sunlight, wind, rain, snow and other weather conditions.
- 5.7 Include in reports all information critical to inspection and testing.
- 5.8 Ensure that only materials from the work and intended for use therein are tested.
- 5.9 Determine locations for work to be tested.
- 6 **TOLERANCES FOR INSTALLATION OF WORK**
- 6.1 Unless specifically indicated otherwise, work shall be installed plumb, level, square and straight.
- 6.2 Unless acceptable tolerances are otherwise specified in specification sections or are otherwise required for proper functioning of equipment, site services, and mechanical and electrical systems:
 - .1 "Plumb and level" shall mean plumb or level within 1 mm in 1 m.
 - .2 "Square" shall mean not in excess of 10 seconds lesser or greater than 90 degrees.
 - .3 "Straight" shall mean within 1 mm under a 1 m long straightedge.
 - .4 "Flush" shall mean within:
 - .1 6 mm for exterior concrete, masonry, and paving materials.
 - .2 1 mm for interior concrete, masonry, tile and similar surfaces.
 - .3 0.05 mm for other interior surfaces.
- 6.3 Allowable tolerances shall not be cumulative.
- 6.4 Be advised that room dimensions for this project are closely coordinated with furniture dimensions. Dimensions indicated on the drawings must be maintained within a tolerance of ± 12 mm throughout the project.
- 6.5 Monitor fabrication and installation tolerance control of products to produce acceptable work. Do not permit tolerances to accumulate.
- 6.6 Comply with manufacturers' tolerances. Should a manufacturer's tolerances conflict with the Contract Documents, request clarification from the Consultant before proceeding.
- 6.7 Adjust products to appropriate dimensions; position products before securing in place.
- 7 **REFERENCE STANDARDS**
- 7.1 Perform inspection and testing in accordance with Standards quoted and as required by procedures described in specified reference standards that are applicable to the work

- being inspected and tested.
- 7.2 Perform the Work in accordance with the latest edition, including all revisions, of applicable codes and regulations of federal, provincial, or local application, provided that, in any case of conflict or discrepancy, the more stringent requirements shall apply.
- 7.3 Meet or exceed the requirements of specified standards, codes and referenced documents.
- 7.4 For materials, products or workmanship specified by association, trade or other consensus standards, comply with the requirements of the standard, except where more rigid requirements are specified or are required by applicable codes.
- 7.5 In each case, where a standard, code or other document is referenced, the latest edition or revision shall apply, unless specified otherwise, except where a specific date of issue is established by code.
- 7.6 Neither the contractual relationships, duties or responsibilities of the parties in the Contract shall be altered from those defined by the Contract Documents by mention or inference otherwise in any referenced document.

8 **DEFECTS**

- 8.1 Defective products, materials and workmanship found at any time prior to Contract Completion will be rejected regardless of previous inspections, testing, and reviews of the Work. Inspections, testing, and reviews shall not relieve the Contractor from their responsibility, but are a precaution against oversight or error. Remove and replace defective and rejected products, materials, systems, and workmanship. Be responsible for delays and expenses caused by rejection.

9 **MOCK UPS**

- 9.1 Where required by Contract Documents construct, unless indicated herein, mock-ups of work on Site, in size and at location directed by Consultant.
- 9.2 Construct mock-ups prior to start of affected work. Allow sufficient time for Consultant's review. Work affected by mock-ups may not commence prior to acceptance of mock-ups.
- 9.3 Construct mock-ups to include all related specified materials and workmanship. Make revisions as directed by Consultant, in accordance with the intent of the Contract Documents, until mock-ups are acceptable.
- 9.4 Mock-ups, reviewed and accepted by Consultant, shall become the standard of quality against which installed work will be measured.
- 9.5 Mock-ups, by prior arrangement, may be incorporated into finished work if approved by Consultant only.
- 9.6 Procedures for the preparation and submission of mock-ups are specified in Section 01 33 00 "Submittal Procedures".
- 9.7 Tests will be performed under the provisions identified in this Section.

10 **DOCUMENTS ON SITE**

- 10.1 Maintain at job site, one copy of each of the following:
- .1 Contract Documents including Drawings, Specifications, Addenda, and other modifications to the Contract.
 - .2 'Reviewed' or 'Reviewed as Modified' Shop Drawings.
 - .3 Project Construction and Shop Drawing Schedules.

- .4 Site Instructions and Change Orders.
- .5 Field Test Reports.
- .6 Reports by Authorities having Jurisdiction.
- .7 Building and other applicable permits.
- .8 Daily log including:
 - .1 Weather conditions.
 - .2 Excavation conditions
 - .3 Start and finish date of each Trade Contractor.
 - .4 Erection and removal dates of formwork.
 - .5 Date, quantities and particulars of each concrete pour.
 - .6 Dates and quantities and particulars of roofing and waterproofing work.
 - .7 Visits to the Site by Owner, Consultants, Jurisdictional Authorities, Testing and Inspection companies, and material and equipment supplier representatives.
 - .8 Material Safety Data Sheet pursuant to WHMIS (Occupational Health & Safety Act).
 - .9 As-built drawings recording as-built conditions, instructions, changes for structure, equipment, wiring, plumbing, etc., as called for in Section 01 78 39 and in other Divisions, prior to being concealed.
 - .10 Copies of applicable codes.
- 10.2 The above material shall be made available to the Consultant at their request.

11 **BUILDING ENVELOPE**

- 11.1 The requirements outlined in this section are applicable to all components of the exterior building envelope.
- 11.2 Maintaining the continuity of the air barrier, vapor retarder, and insulation systems is essential at all locations. Where different systems interface, ensure proper integration and continuity by utilizing appropriate construction methods and ensuring the use of compatible materials.
- 11.3 The maximum allowable air leakage rate is 0.10 L/(s·m²), tested under conditions of a warm-side relative humidity between 27% and 55% at 21°C, with an air pressure differential of 75 Pa. Alternatively, the requirements of the latest version of the Canada Green Building Council's (CaGBC) Zero Carbon Building – Design Standard shall be followed if they are more stringent.
- 11.4 Secure exterior cladding elements to the structure in a manner that accommodates structural movement, deflection, and creep while resisting temperature gradient loads. The anchorage system must be designed to withstand positive and negative wind pressures in compliance with relevant regulations.
- 11.5 Ensure that air spaces within exterior building components are appropriately firestopped, adhering to all applicable codes and regulations.
- 11.6 Provide adequate drainage systems for air spaces external to vertical air barrier/vapor retarder systems, window assemblies, and curtain wall systems to direct water to the exterior effectively.
- 11.7 Owner reserves the right to perform a thermographic scan of the building envelope upon project completion. The Contractor will be responsible for rectifying any thermal anomalies identified during this process.

12 DRAINAGE

- 12.1 Layout and construct work to ensure that positive drainage is provided to floor drains, ditches, site drains and catch basins, as set in their final position, preventing undrained areas and ponding.
- 12.2 Ensure that allowable construction tolerances and structural deflection do not cause ponding of water.
- 12.3 Report to Consultant in writing prior to executing work affected, in case adequate drainage cannot be provided.

END OF SECTION

1 GENERAL

- 1.1 Provide Labour, Products, equipment, services, tools and Supervision to ensure that Work complies with minimum acceptable standards of materials and performance of Work in accordance with codes and standards referenced in the Specification.
- 1.2 Consider contract forms, codes, Specifications, standards, manuals, and installation and application instructions referred to in these specifications to be the latest published editions at the date of submission of the bid unless otherwise stated in the Specifications or otherwise required by the authorities having jurisdiction.

2 BY-LAWS, PERMITS, AND FEES

- 2.1 The Building Code - Ontario Regulation 332/12, including all amendments, shall govern the construction of the Work.
- 2.2 Comply with all By-Laws and regulations of authorities having jurisdiction. These codes and regulations constitute an integral part of the Contract Documents.
- 2.3 Owner shall apply and pay for Municipal Building Permit, and Contractor shall obtain and pay for all other permits, licenses, deposits, and certificates of inspection as part of the Contract Price as per Conditions of the Contract. Ensure that permits, licenses, deposits, and certificates included under specific Sections are provided as specified.
- 2.4 If required, pay for construction damage deposit required by authorities having jurisdiction.
- 2.5 Where permits, licenses, and inspection fees are required by authorities having jurisdiction for specific trade functions, they shall be obtained by particular subtrade responsible for that work.
- 2.6 Arrange for inspection, testing of Work and acceptance required by the authorities having jurisdiction. Be responsible for necessary preparations, provisions and pay all associated costs.
- 2.7 Be responsible for ensuring that no work is undertaken which is conditional on permits, approvals, reviews, licenses, fees, until all applicable conditions are met. No time extension will be allowed for delay in obtaining necessary permits.
- 2.8 Any additional work or changes to the materials due to Work not complying with the Ontario Building Code and Regulations as indicated by the Building Inspector shall be changed. All costs involved shall be borne by Contractor.
- 2.9 Obtain permit required to work on Municipal rights of way. Provide damage deposits for sidewalks, roads and services work, as applicable.
- 2.10 Give notice of completion of project prior to occupancy, as required by applicable legislation.

3 **EXISTING PUBLIC SERVICE LINES**

- 3.1 Where existing public services are indicated to be removed and/or relocated, perform Work in compliance with authorities having jurisdiction.
- 3.2 Make good public roads, walkways and curbs soiled or damaged due to construction to the requirements of local authorities.

4 **CODES**

- 4.1 Reference is made to standards in the specifications to establish minimum acceptable standards of materials, products and workmanship. Ensure that materials, products and workmanship meet or exceed requirements of the reference standards specified.
- 4.2 In the event of conflict between documents specified herein, execute the Work in accordance with the most stringent requirements.

5 **STANDARDS**

- 5.1 Where a material or product is specified in conjunction with a referenced standard, do not supply the material or product if it does not meet the requirements of the standard. Supply another specified material or product, or an acceptable material or product of other approved manufacture which does meet the requirements of the standard, at no additional cost to the Owner.
- 5.2 Where no standard is referred to, provide materials, products and workmanship which meet requirements of the applicable standards of the Canadian Standards Association, Canadian General Standards Board, Ontario Provincial standard specifications (OPSS), Ontario Provincial Standard Drawings (OPSD) and the applicable building code. References to "Measurement for Payment" and "Basis of Payment" in OPSS standard documents are not applicable to this Contract.
- 5.3 If there is question as to whether a material, product or system is in conformance with applicable standards, the Consultant reserves the right to have such materials, products or systems tested to prove or disprove conformance. The cost for such testing will be paid by the Owner in the event of conformance with contract Documents or by the Contractor in the event of non-conformance.
- 5.4 Where application, installation and workmanship standards are cited, it is intended that referenced standards form the basis for minimum requirements of the specified item and specifications supplement the standards unless specified otherwise.
- 5.5 Matters may be dealt with in part by these specifications which are also dealt with, under the same or similar headings in cited standard. It is not intended that these specifications take the place of the standards but supplement them, unless specified otherwise.

- 5.6 Where reference is made to manufacturer's directions, instructions or specifications they shall include full information on storing, handling, preparing, mixing, installing, erecting, applying, or other matters concerning the materials pertinent to their use and their relationship to materials with which they are incorporated.
- 5.7 Where standards, specifications, associations, and regulatory bodies are listed in the Specifications by their abbreviated designations. These are but not limited to the following:

AA: The Aluminum Association
AAMA: Now part of FGIA (Fenestration and Glazing Industry Alliance)
AASHTO: American Association of State Highway and Transportation Officials
ACI: American Concrete Institute
AFBMA: Anti-Friction Bearing Manufacturer's Association
AIEE: Merged with IRE to form IEEE (Institute of Electrical and Electronics Engineers)
AISI: American Iron and Steel Institute
AMCA: Air Movement and Control Association
AMEU: Association of Municipal Electric Utilities
ANSI: American National Standards Institute
ARI: Now AHRI (Air-Conditioning, Heating, and Refrigeration Institute)
ASA: Now ANSI (American National Standards Institute)
ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME: American Society of Mechanical Engineers
ASTM: Now ASTM International
AWMAC: Architectural Woodwork Manufacturers Association of Canada
AWWA: American Water Works Association
CAGBC: Canada Green Building Council
CEMA: Canadian Electrical Manufacturer's Association
CGA: Canadian Gas Association
CGSB: Canadian General Standards Board
CISC: Canadian Institute of Steel Construction
CMHC: Canadian Mortgage and Housing Corporation
CMPA: Canadian Paint Manufacturers Association
COFI: Council of Forest Industries of British Columbia
CRCA: Canadian Roofing Contractors Association
CSA: Canadian Standards Association
CSSBI: Now part of CISC (Canadian Institute of Steel Construction)
CWB: Canadian Welding Bureau
CWC: Canadian Wood Council
EEMAC: Electrical and Electronic Manufacturers Association Canada
FHIA: Florida Home Improvement Association
FM: Factory Mutual
FGIA: Fenestration and Glazing Industry Alliance (formerly AAMA and IGMA)
IGMA: Now part of FGIA (Fenestration and Glazing Industry Alliance)
IEEE: Institute of Electrical and Electronics Engineers
MFMA: Maple Flooring Manufacturers Association
MIL: Often replaced with specific DoD Standards (Department of Defense Standards or MIL-SPECS)
MSS: Manufacturer's Standardization Society
MTO: Ministry of Transportation Ontario
NAAMM: National Association of Architectural Metal Manufacturers
NFPA: National Fire Protection Association
NEMA: National Electrical Manufacturer's Association
NLGA: National Lumber Grades Authority
NRC: National Research Council of Canada

OCBA: Ontario Concrete Block Association
OHESC: Ontario Hydro Electrical Safety Code
OPSS: Ontario Provincial Standard Specification
PEI: Porcelain Enamel Institute
PDI: Plumbing Drainage Institute
PHA: Public Health Act
SMACNA: Sheet Metal and Air Conditioning Contractors National Association
SSPC: Now part of AMPP (Association for Materials Protection and Performance)
TEMA: Tubular Exchange Manufacturer's Association
TTMAC: Terrazzo, Tile and Marble Association of Canada
UL: Underwriters Laboratories Inc.
ULC: Underwriters Laboratories of Canada

6 FIRE RATINGS, ASSEMBLIES AND SEPARATIONS

- 6.1 Where a material, component, assembly, or separation is required to be fire rated, the fire rating shall be as determined or listed by one of the following testing authorities acceptable to the authorities having jurisdiction:
- .1 Underwriters' Laboratories of Canada.
 - .2 Underwriters' Laboratories Inc.
 - .3 Factory Mutual Laboratories.
 - .4 The National Research Council of Canada.
 - .5 The National Board of Fire Underwriters.
 - .6 Intertek Testing Services.
- 6.2 Where reference is made to only one testing authority an equivalent fire rating as determined or listed by another of the aforementioned testing authorities is acceptable if approved by authorities having jurisdiction. Obtain and submit such approval of authorities, in writing when requesting acceptance of a proposed equivalent rating or test design.
- 6.3 Fire rated door assemblies shall include doors, frame, anchors, and hardware and shall bear label of fire rating authority showing opening classification and rating.
- 6.4 Material having a fire hazard classification shall be applied or installed in accordance with fire rating authorities printed instructions. Fire rated assemblies shall be constructed in
- 6.5 accordance with applicable fire test report information issued by fire rating authority. Deviation from fire test report will not be allowed.
- 6.6 Construct fire separations as continuous, uninterrupted elements except for permitted openings. Extend fire rated walls and partitions from floor to underside of structural deck above.
- 6.7 Fire separations may be pierced by openings for electrical and similar service outlets provided such boxes are non-combustible and are tightly fitted and sealed with a ULC approved sealant for the assembly being sealed.
- 6.8 Construction that abuts on or is supported by a non-combustible fire separation shall be constructed so that its collapse under fire conditions will not cause the collapse of the fire separation.
- 6.9 Do not use combustible members, fastenings, attachments and similar items to anchor electrical, mechanical or other fixtures to fire separations.

- 6.10 At penetration through fire rated walls, ceilings or floors, completely seal voids with ULC approved firestopping material; full thickness of the construction element. In locations that require a smoke seal, provide appropriate ULC approved system installed in accordance with the manufacturer's recommendations.

END OF SECTION

1 **GENERAL**

- 1.1 The provisions outlined in the Contract, including the general and supplementary conditions as well as Division 1 Specification Sections, are applicable to this section.

2 **INDEPENDENT INSPECTION AND TESTING AGENCIES**

- 2.1 Independent inspection and testing agencies may be retained by the Owner to inspect and test specific portions of the Work.
- 2.2 The Owner will cover the cost of initial inspections and tests.
- 2.3 Any reinspection or retesting required due to non-compliance with the Contract Documents during the initial inspection or test shall be at the Contractor's expense.

3 **SCOPE OF WORK**

- 3.1 Inspections and tests will be overseen by the Contractor.
- 3.2 The involvement of inspection and testing agencies does not absolve the Contractor or Subcontractors of their obligation to perform the Work in full compliance with the Contract Documents, schedules, and approved shop drawings. Inspections and tests serve only as a verification aid.
- 3.3 Subcontractors remain responsible for supplying the specified products and ensuring that the Work meets the Contract Documents, regardless of inspection and testing.
- 3.4 Inspection and testing agencies must report any observed deviations from the Contract Documents to the Contractor. Instructions to these agencies will be provided by the Contractor.
- 3.5 Inspection and testing agencies are not responsible for supervising, teaching current methods, or determining acceptance or rejection of Work; their role is solely to examine and report on conditions.

4 **CONTRACTOR'S RESPONSIBILITIES**

- 4.1 Provide a complete set of Contract Documents, including all addenda, for use by inspection and testing agencies. Notify Subcontractors and the Consultant of scheduled inspections and testing appointments.
- 4.2 Notify the appropriate inspection and testing agencies at least 48 hours before any Work requiring inspection or testing begins. Ensure facilities are available and cooperate fully with the agencies and their inspectors.
- 4.3 Ensure the following:
- .1 Provide unrestricted access to the Work at all times.
 - .2 Facilitate inspections by providing sufficient, safe, and suitable facilities.
 - .3 Ensure access to off-site Work when applicable.
 - .4 Supply material samples, design mixes, tools, storage, and incidental labor as required.
 - .5 Provide reasonable notice to the Consultant and relevant inspection agencies about when Work requiring inspection or testing will be ready.
 - .6 Notify the Consultant in advance about inspection times by other authorities.

- .7 Ensure inspection and testing agencies are present at the start of all Work that requires inspection or testing.
- .8 Arrange and pay for additional samples and tests as needed.
- .9 Do not cover completed Work with subsequent construction until it has been reviewed by the inspection and testing agency or the Consultant.

5 SUBCONTRACTORS' RESPONSIBILITIES

- 5.1 Subcontractors must notify the Contractor at least 72 hours before commencing Work requiring inspection or testing.
- 5.2 Provide full access and cooperate with inspectors during required inspections and tests.
- 5.3 Replace any products deemed non-compliant in inspection and test reports as instructed by the Contractor, at no additional cost to the Contract.
- 5.4 Rectify improper installations noted in inspection and test reports as directed by the Contractor, without affecting the Contract Price.
- 5.5 Cover the cost of reinspection and testing of replaced Work as directed by the Contractor. Subcontractors are responsible for any delays caused by the need to correct Work.
- 5.6 Notify the Contractor, Consultant, and inspection agencies at least 48 hours prior to starting Work that requires inspection or testing.
- 5.7 Ensure the presence of authorized inspection and testing agencies at the beginning of Work requiring their involvement.
- 5.8 Do not cover completed Work with subsequent construction until reviewed by the inspection and testing agency or the Consultant.
- 5.9 Ensure inspection and testing reports are issued promptly, typically within 48 hours, and inform the Contractor and Consultant immediately if issues arise.
- 5.10 Provide necessary facilities and equipment for inspection and testing, including proper storage for concrete specimens as instructed by inspection agencies. Cover testing costs for unidentified reinforcing steel.

6 INSPECTION AND TESTING AGENCIES' RESPONSIBILITIES

- 6.1 Inspection and testing agencies and their personnel must be independent and unaffiliated with the Contractor, Subcontractors, suppliers, or others involved in the Work. Agencies must provide evidence of experience if requested by the Contractor.
- 6.2 Review and understand the intent and requirements of the Contract Documents, including addenda.
- 6.3 Perform all required inspections and tests as specified in the Contract Documents and individual specification sections.
- 6.4 Notify the Contractor of each visit to the site, plant, or mill.
- 6.5 Promptly provide inspection and test reports to the Contractor, Consultant, and any other parties designated by them.

- 6.6 Inform the Contractor immediately of any non-compliance observed during inspections. Decisions on acceptance or rejection of Work remain the responsibility of the Consultant.

7 MANUFACTURERS' FIELD SERVICES

- 7.1 When specified, suppliers or manufacturers must provide qualified personnel to assess site conditions, installation quality, equipment startup, and testing. They must offer guidance as needed.
7.2 Document and report observations or any instructions given on-site that deviate from the manufacturer's written guidelines.

8 REPORTS AND DISTRIBUTION

- 8.1 Inspection and test reports must be comprehensive, individually documented, and signed by an authorized representative of the inspection/testing agency. Distribute reports to Consultant.

- 8.2 Reports must include:

- .1 Name of the inspection/testing agency
- .2 Project, Owner, Consultant, and Contractor details
- .3 Dates of inspection and reporting
- .4 Weather and temperature conditions
- .5 Exact test locations
- .6 Comments on workmanship
- .7 Deviations from Contract Documents or accepted practices

9 SPECIFIC INSPECTION AND TESTING REQUIREMENTS

- 9.1 Inspection and testing by Owner-appointed agencies will be conducted for select building elements, including:

- .1 Earthwork
- .2 Concrete
- .3 Reinforcing steel
- .4 Waterproofing
- .5 Membrane air/vapor/moisture barriers
- .6 Roofing and sheet metal flashing
- .7 Building envelope

- 9.2 Refer to individual specification sections for detailed requirements on inspection and testing.

END OF SECTION

1 **TEMPORARY CONTROLS**

1.1 Hoarding and Barriers

.1 Before initiating construction activities, supply, erect, and maintain hoarding around the entire perimeter of the site. Ensure the exterior is painted in a Consultant-approved color and display "POST NO BILLS" signage.

.2 Provide temporary enclosures to shield the building or parts thereof from adverse weather, maintain necessary environmental conditions, and protect materials stored inside.

.3 Install lockable gates in the hoarding or barriers to allow controlled access for workers and vehicles.

1.2 Prevent unauthorized entry to the site by barricading, guarding, or locking access points. Display "NO TRESPASSING" signs prominently.

1.3 Install hoarding, barriers, and covered walkways as required by authorities to safeguard public areas, access routes, and adjacent properties. Use materials other than snow fencing for sidewalk protection.

1.4 Ensure temporary ramps, guardrails, and handrails are provided to facilitate safe, barrier-free access for the public to existing facilities during construction.

1.5 Install and maintain clear directional signage to guide individuals through or around the worksite, as directed by the Consultant.

1.6 Provide secure, rigid guide rails and barriers around excavations, open shafts, stairwells, and floor edges to protect workers and the public.

1.7 Upon completion of the project, remove all hoarding, barriers, and other temporary structures unless otherwise specified by contract drawings or the Consultant.

1.8 Construct and maintain hoardings, barriers, guardrails, overhead protection, and safety signage to secure the site and protect public safety.

1.9 Ensure compliance with applicable federal, provincial, and municipal regulations. Obtain necessary permits and approvals for all safety measures.

1.10 Supply and maintain construction facilities and temporary controls to ensure efficient execution of the Work.

1.11 Before achieving Substantial Completion, remove all temporary facilities and controls from the site.

- 1.12 Repair or restore any damage or disruption to existing property caused by construction activities, ensuring the restored property meets or exceeds its original condition.

2 SERVICE AND UTILITY SYSTEMS

- 2.1 Coordinate with utility companies and local authorities to determine the exact location of existing services in or near the construction site.
- 2.2 Information shown in the project drawings regarding utilities does not eliminate the Contractor's responsibility to verify exact locations.
- 2.3 Provide necessary notifications and coordinate with relevant authorities for service connections.
- 2.4 Bear any associated charges for utility work, unless stated otherwise in the contract.
- 2.5 Maintain active utility systems affected by construction activities until project handover or specific portions are accepted by the Owner.
- 2.6 Report any unknown services encountered during excavation to the Consultant and follow their directives for further action.

3 SCAFFOLDING, HOISTS, AND CRANES

- 3.1 Choose, operate, and maintain scaffolding, hoists, and cranes in compliance with safety standards to avoid risks to structures, utilities, and public areas.
- 3.2 Ensure scaffolding is designed and constructed according to CAN/CSA S269.2-M standards.

4 TEMPORARY WORKS

- 4.1 Supply and maintain temporary utilities, including electrical, water, and heating, required to execute construction. Remove all temporary facilities after their use is complete.
- 4.2 Provide and maintain a continuous supply of potable water for construction activities. Arrange water connections to meet project needs, including connections on each floor where applicable.
- 4.3 Disconnect temporary water lines and repair any associated damages upon project completion.
- 4.4 Temporary Water Service
- .1 Arrange and pay for water supply needed during construction, connecting to delivery points approved by the relevant authorities.

- .2 Install all necessary temporary piping and hoses to transport water to required locations.
- 4.5 Temporary Heating
 - .1 Provide heating as required to maintain at least 10°C in active work areas, unless otherwise specified.
 - .2 Use flameless or vented heaters to ensure adequate ventilation and prevent gas accumulation.
- 4.6 Temporary Ventilation
 - .1 Provide adequate ventilation in enclosed spaces to facilitate material curing, reduce humidity, and prevent accumulation of fumes, vapors, or dust.
- 4.7 Electrical and Lighting Systems
 - .1 Install temporary electrical systems in compliance with the Ontario Hydro Electrical Safety Code. Obtain inspection certificates for all installations.
 - .2 Provide sufficient lighting to ensure safe construction activities and public access during nighttime.
- 4.8 Temporary Electrical Power
 - .1 Arrange and cover costs for temporary electrical power required during the construction phase, including lighting and power tools.
 - .2 Ensure connections are compliant with the Canadian Electrical Code and approved by the relevant local authority. Provide necessary equipment and temporary wiring to deliver power to points of use, including flexible power cords.
 - .3 Utilize the building's permanent electrical system for construction purposes only if doing so does not compromise warranties.
- 4.9 Temporary Lighting
 - .1 Install and maintain temporary lighting to achieve a minimum illumination level of 2 watts per square foot (21 watts per square meter) for construction operations.
 - .2 Arrange and pay for additional task-specific lighting where needed. Extend wiring from power sources to distribution points with appropriate conductors, pigtails, and lamps.
 - .3 Provide adequate lighting for staging and storage areas, including security lighting after dark.

- .4 Use the building's permanent lighting systems only if warranties remain unaffected.
- 4.10 Temporary Telecommunication
 - .1 Install telephone, computer and high-speed internet services for use by construction personnel, the Consultant, and the Owner.
 - .2 Costs for long-distance calls or transmissions shall be borne by the party initiating them.
- 4.11 Temporary Sanitary Facilities
 - .1 Provide adequate temporary washroom facilities for construction worker.
 - .2 Ensure these facilities are cleaned and maintained in compliance with municipal and provincial health and safety guidelines.
- 5 **PROTECTION**
 - 5.1 Protect adjacent properties, public areas, and existing infrastructure from potential damage due to construction activities. Immediately address any damages at the Contractor's expense.
 - 5.2 Shield finished and in-progress work from potential harm using temporary covers, barriers, and protective measures. Ensure damaged materials or finishes are replaced with matching products at no additional cost to the Owner.
 - 5.3 Implement fire protection measures, including on-site extinguishers and compliance with local fire codes. Prohibit the open burning of materials.
 - 5.4 Erect temporary enclosures to seal openings in the building, such as doors, windows, and shafts, protecting interiors from weather exposure.
 - 5.5 Ensure the interior work area is enclosed to support temporary heating requirements.
 - 5.6 Install dust-tight partitions to confine dust-generating activities and safeguard workers, finished areas, and the public.
 - 5.7 Adjust and maintain these protections as necessary until the relevant tasks are complete.
 - 5.8 Safeguard completed work by employing specified protective measures, including removable protections.
 - 5.9 Cover surfaces such as walls, openings, floors, and stairs to prevent dirt, damage, or wear from ongoing construction activities.

- 5.10 Prohibit unauthorized traffic or material storage on waterproofed or landscaped surfaces unless appropriately protected.

6 **PEST CONTROL**

- 6.1 Implement pest control measures to prevent the spread of rodents, insects, or other pests during construction. Follow Canada Pest Control Products Act and local regulations for pesticide use.

7 **FIRST-AID FACILITIES**

- 7.1 Provide and maintain first-aid equipment and medical facilities on-site, as mandated by the Workplace Safety and Insurance Act.

7.2 **USE OF PERMANENT SERVICES AND EQUIPMENT**

- 7.3 Obtain Owner's written permission before using any permanent services or equipment.
- 7.4 Ensure services and equipment used temporarily are returned in "like-new" condition without impacting warranties.

8 **SITE IDENTIFICATION**

- 8.1 Do not display signs without prior written approval from the Consultant and Owner. Maintain signage in good condition throughout the project duration.

9 **SITE MAINTENANCE**

- 9.1 Keep the site and surrounding areas clean and orderly. Dispose of debris and waste promptly to avoid accumulation.
- 9.2 If the site is not cleaned within 48 hours of receiving a directive, the Consultant may arrange cleaning at the Contractor's expense.

10 **SITE STORAGE AND OVERLOADING**

- 10.1 Store materials and equipment only in designated areas approved by the Consultant. Do not store items in public view or areas not allocated for such use.
- 10.2 Ensure no portion of the site or structure is overloaded beyond its designed capacity. Address damages resulting from overloading immediately and at no cost to the Owner.
- 10.3 Avoid obstructing the site with excessive materials or equipment. Follow storage instructions provided by the Consultant.

- 10.4 Secure additional storage areas as necessary, bearing the associated costs.
- 10.5 Do not overload any part of the structure or site with materials beyond its safe capacity.
- 11 **PUBLIC CONVENIENCE AND SAFETY**
 - 11.1 Maintain safe sidewalks and access routes throughout construction. Promptly remove snow and debris to ensure public safety.
 - 11.2 Keep haul routes clean of materials and debris resulting from construction activities. Clean roads and sidewalks within 24 hours of receiving instructions from the Consultant.
- 12 **ACCESS AND EGRESS TO SITE**
 - 12.1 Where required, construct access roads capable of handling construction traffic and equipment. Maintain these roads in a safe and operable condition throughout the project.
 - 12.2 Remove access roads upon project completion unless otherwise indicated in the contract documents. Restore affected areas as specified in the drawings.
- 13 **PUBLIC TRAFFIC FLOW**
 - 13.1 Provide and maintain traffic control measures such as flag personnel, police officers, traffic signals, barricades, and appropriate lighting to ensure the safety of the public and construction workers. Comply with the requirements of authorities having jurisdiction.
- 14 **PUBLIC UTILITIES AND SERVICES**
 - 14.1 Confirm limitations and restrictions imposed by the presence of utilities and services on or near the site. Ensure no damage occurs to these facilities during construction activities.
 - 14.2 Notify relevant utility providers for any required relocation, protection, or discontinuation of services.
 - 14.3 Arrange and pay for connections to utility services required for the project. Ensure that service installations are placed in inconspicuous locations or as directed by the Consultant.
- 15 **ROADS, CURBS, GUTTERS, AND WALKS**
 - 15.1 Perform necessary modifications, such as curb cuts and repairs, to existing municipal infrastructure to meet the requirements of authorities having jurisdiction. Ensure all approaches are properly paved and finished.

16 **CONSTRUCTION PARKING**

- 16.1 Parking for construction personnel is permitted on-site provided it does not obstruct construction progress, compromise site safety, or hinder pedestrian or vehicular movement. Parking arrangements must be acceptable to the Consultant.

17 **SITE VISITORS**

- 17.1 Allow authorized visitors, as designated by the Consultant, access to the site during the course of the work. Facilitate inspections or testing as required. Maintain a logbook to record all visitors to the site.
- 17.2 Ensure all visitors wear appropriate safety equipment in compliance with site safety protocols.

18 **SECURITY**

- 18.1 Implement security measures, including lockable facilities, to prevent unauthorized access, vandalism, or theft.
- 18.2 Media or news outlets are strictly prohibited from accessing the site without obtaining prior written authorization from the Owner. Enhanced security measures will be implemented to prevent unauthorized entry to the site. Only individuals with explicit clearance from the Owner or designated authorities will be permitted access, and all personnel must strictly comply with the established security protocols at all times.

19 **EROSION AND SEDIMENTATION CONTROL**

- 19.1 Control site drainage to prevent flooding, erosion, or run-off onto adjacent properties. Dispose of water containing silt or other suspended materials in accordance with jurisdictional requirements.
- 19.2 Install and maintain sediment control devices at catch basins, drainage courses, and other designated locations until the completion of construction or as directed by the Consultant.
- 19.3 Protect storm drain inlets with sediment barriers or excavated ponding areas. Inspect and maintain these protections after each rainfall, removing sediment as needed.

20 **TEMPORARY DRAINAGE AND DEWATERING**

- 20.1 Keep drainage lines and gutters open and functional at all times. Prevent water from flowing across pavements by using pipes or properly constructed troughs.
- 20.2 Keep trenches and other excavations free of water using suitable methods to maintain soil stability. Dispose of water in a manner that does not endanger public health, property, or construction progress.

21 **SNOW REMOVAL**

- 21.1 Prevent accumulation of snow and ice on-site, especially on roof decks or areas scheduled for roofing operations.
- 21.2 Remove snow and ice from access roads, pathways, and parking areas to ensure uninterrupted construction activities.

22 **POLLUTION CONTROL**

- 22.1 Cover or wet down dry materials and rubbish to prevent dust from becoming airborne. Provide effective dust control measures for temporary roads and work areas.
- 22.2 Remove waste materials from the site in compliance with local regulations. Arrange and pay for the proper disposal of construction debris.
- 22.3 Limit noise levels generated by construction equipment and activities in accordance with local bylaws and regulations.
- 22.4 Prevent emissions from construction activities, such as abrasive blasting, from contaminating air beyond the immediate work area. Use temporary enclosures or other containment measures as needed.

23 **TREE PROTECTION**

- 23.1 Protect existing trees and vegetation designated to remain by installing a minimum 1.8-meter-high chain-link fence around the drip line of trees or groups of plants.
- 23.2 Avoid disturbing fenced-off areas or using them for storage or dumping. Do not attach rigging or cables to trees.
- 23.3 Where tree limbs or roots are affected by construction, prune or treat them in accordance with accepted arboricultural practices to minimize harm.
- 23.4 Obtain approval from the Consultant before altering grades or performing work near existing trees and vegetation.

24 **FIELD OFFICES**

- 24.1 Provide adequately sized offices to accommodate site meetings and administrative needs. Equip necessary furniture, and washroom facilities.

25 PROJECT CLEANLINESS

- 25.1 Maintain a clean and organized site by regularly disposing of waste materials and debris.
- 25.2 Clear debris from concealed spaces, such as attics and pipe chases.
- 25.3 Sweep and vacuum interiors before finishing work begins to ensure a dust-free environment.
- 25.4 Prohibit the use of open chutes; instead, ensure waste is directed into proper containers with lids.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

- .1 This Section includes requirements related to enclosing and accessing the Site and preventing nuisances and hazards in the vicinity of the Site as a result of the Work.
- .2 Project specific requirements are to be as indicated on the drawings.
 - .1 Requirements for barriers and fences for the protection of trees and natural features are described elsewhere.

1.2 INSTALLATION AND REMOVAL

- .1 Provide temporary controls in order to execute Work expeditiously.
- .2 Remove from site all such work after use.

1.3 HOARDING

- .1 Provide continuous portable, sectional metal fencing enclosure around entire work area.
 - .1 Hoarding system used shall be provided as a complete system with fasteners, stands and all other components provided for all sections of hoarding.
 - .2 Hoarding materials shall be clean and in good condition, free from damages, gaps, protruding wires or other hazards.
 - .3 Any hoarding materials determined by the Consultant or Owner to be in an unacceptable condition shall be removed from the site and replaced immediately.
- .2 Contractor shall provide any supports or bracing as may be required to ensure the fence is stable and secure.
 - .1 Where hoarding is used in lieu of City-standard tree protection barriers, or where hoarding is used to demarcate a natural feature, hoarding shall be securely fastened or staked to grade on the inside of the enclosed area.
 - .2 Where hoarding is installed adjacent a public sidewalk or path, trip covers shall be used over any bases or feet encroaching into the travelled path.
- .3 Site work shall not commence until acceptance of hoarding.
- .4 Hoarding shall not be removed until so directed by Owner or Consultant.

1.4 DUST TIGHT SCREENS

- .1 Provide dust tight screens or partitions to localize dust generating activities, and for protection of workers, finished areas of Work and public.
- .2 Maintain and relocate protection until such work is complete.

1.5 ACCESS TO SITE

- .1 Provide and maintain access roads, sidewalk crossings, ramps and construction runways as may be required for access to Work.
- .2 Provide access only at locations accepted by the Owner.

1.6 PUBLIC TRAFFIC FLOW

- .1 Provide and maintain competent signal flag operators, traffic signals, barricades and flares, lights, or lanterns as required to perform Work and protect public.

1.7 EMERGENCY ACCESS

- .1 Maintain access to property including overhead clearances for use by emergency response vehicles.

1.8 PROTECTION FOR OFF-SITE AND PUBLIC PROPERTY

- .1 Protect surrounding private and public property from damage during performance of Work.
- .2 Be responsible for damage incurred.

PART - 2 PRODUCTS

2.1 NOT USED

- .1 Not used.

PART - 3 EXECUTION

3.1 NOT USED

- .1 Not used.

END OF SECTION 01 56 00

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section includes general protection and arboricultural works for existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.
- .2 Tree protection measures indicated on drawings may be installed and maintained by others as a requirement of adjacent works.
 - .1 Where tree protection measures are under control of other parties, the Contractor for this work shall not be responsible for maintenance of such measures.
 - .2 Upon completion of adjacent works, Contractor for this work shall either assume control of existing tree protection measures or shall request existing tree protection measures to be removed and replace them with new.
 - .3 Upon assuming control of tree protection measures or erecting new tree protection measures, Contractor for this work assumes responsibility to maintain the measures for the duration of works as described herein and in accordance with bylaws and standards referred to below.

1.2 RELATED REQUIREMENTS

- .1 Section 01 41 00 Regulatory Requirements
- .2 Section 01 56 00 Temporary Barriers and Enclosures
- .3 Section 32 11 23 Aggregate Base Courses

1.3 REFERENCE STANDARDS

- .1 City of Toronto Tree Protection Policy and Specifications for Construction Near Trees, July 2016 or latest version.
- .2 Toronto Urban Forestry (Tree Protection and Plan Review aka TPPR) Permit:
 - .1 Consultant and Owner have coordinated project works with TPPR. Contractor is responsible for compliance with requirements as incorporated into Contract documents.
- .3 Toronto Ravine and Natural Feature Protection (RNFP) Permit:
 - .1 Consultant and Owner have coordinated project works with RNFP. Contractor is responsible for compliance with requirements as incorporated into Contract documents.
- .4 Canadian Society of Landscape Architects (CSLA)/ Canadian Nursery Landscape Association (CNLA)
 - .1 Canadian Landscape Standard, Second Edition
 - .2 Canadian Nursery Stock Standard, Ninth Edition

1.4 REFERENCE DOCUMENTS

- .1 ARBORIST REPORT:
 - .1 Arborist inventory of the site from summer 2023 may be provided upon request.

1.5 DEFINITIONS

- .1 Tree-Protection Zone (aka TPZ): Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings.
 - .1 For by-law regulated trees, dimensions of TPZ shall conform to the "Tree Protection Policy and Specifications for Construction Near Trees" unless otherwise indicated.

1.6 QUALITY ASSURANCE

- .1 Furnish proof of Arborist's qualifications upon request:
 - .1 Certified Arborist as certified by ISA
 - .2 Minimum of 5 years arboricultural experience.
- .2 Furnish proof of professional tree care personnel qualifications upon request:
 - .1 Personnel or company employed for tree care work shall be primarily engaged in such work and shall be a member in good standing of Landscape Ontario.
 - .2 Supervisor / crew leader to have minimum of 5 years professional tree care experience.

1.7 CLOSEOUT SUBMITTALS

- .1 Submit arborist report summarizing all arboricultural works completed. Report shall include the following information:
 - .1 Name of supervising arborist.
 - .2 Date or dates for each measure implemented.
 - .3 Observations of any exposed conditions (ie roots uncovered by excavations)
 - .4 Photographs, drawings and/or plan mark-ups as necessary to illustrate the work completed.
- .2 The report may include recommendations for additional work to preserve or improve the condition of trees on or near the site, however no additional work shall be undertaken without written authorization from the Consultant, Owner or authorities having jurisdiction where applicable.

PART - 2 PRODUCTS

2.1 PROTECTION-ZONE FENCING

- .1 Tree protection fencing for by-law regulated trees shall comply with Toronto Urban Forestry Detail TP-1 unless otherwise indicated.
 - .1 Portable, sectional metal fencing is not an acceptable protection fence for by-law regulated trees.
- .2 Tree protection fencing for by-law regulated trees shall conform to one of the following types, as indicated on the drawings:
 - .1 Plywood Protection-Zone Fencing:
 - .1 Plywood sheathing securely attached to a 2-by-4-inch preservative-treated wood frame, with posts spaced not more than 2400 mm apart
 - .2 Provide supports fixed in place at each post on the outside of the tree protection zone unless otherwise indicated.
 - .3 Height: 1200 mm or 2400 mm as indicated.
 - .4 Provide inspection windows as detailed.
 - .2 Plastic Protection-Zone Fencing with wood frame:
 - .1 Plastic construction fencing / snow fencing in high-visibility orange color, constructed of high-density extruded and stretched polyethylene fabric with 2-inch (50 mm) maximum opening in pattern, securely attached to a 2-by-4-inch preservative-treated wood frame, with posts spaced not more than 96 inches (2400 mm) apart and cross-bracing in each section.
 - .2 Provide supports fixed in place at each post on the outside of the tree protection zone unless otherwise indicated.

- .3 Height: 1200 mm or 2400 mm as indicated.
- .3 Combination Plywood and Plastic Protection-Zone Fencing with wood frame:
 - .1 Plywood sheathing (bottom 1200 mm) and plastic construction fencing / snow fencing (upper 1200 mm) in high-visibility orange color, constructed of high-density extruded and stretched polyethylene fabric with 2-inch (50 mm) maximum opening in pattern, securely attached to a 2-by-4-inch preservative-treated wood frame, with posts spaced not more than 96 inches (2400 mm) apart.
 - .2 Provide supports fixed in place at each post on the outside of the tree protection zone unless otherwise indicated.
 - .3 Height: 2400 mm.
- .4 Plastic Protection-Zone Fencing with t-bar posts:
 - .1 Plastic construction fencing / snow fencing in high-visibility orange color, constructed of high-density extruded and stretched polyethylene fabric with 2-inch (50 mm) maximum opening in pattern, securely supported by T-shape steel posts spaced not more than 2400 mm apart. High-visibility orange color.
 - .2 Height: 1200 mm.
- .5 Portable, sectional metal fencing compliant with Section 01 56 00 Temporary Barriers and Enclosures.
- .6 Gates: Swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones.
 - .1 Do not provide gates unless indicated on the drawings.

2.2 PROTECTION-ZONE SIGNAGE

- .1 Shop-fabricated, rigid plastic sign with attachment holes pre-punched and reinforced; signs to be professionally printed with nonfading lettering.
 - .1 Content of sign shall be as detailed in "Tree Protection Policy and Specifications for Construction Near Trees"
 - .2 Signs are available free-of-charge from the City.

2.3 OTHER MATERIALS

- .1 Compost:
 - .1 Mixture of soil and decomposing organic matter used as fertilizer, mulch, or soil amendment.
 - .2 Compost is processed organic matter containing 40% or more organic matter as determined by Walkley-Black or Loss On Ignition (LOI) test.
 - .3 Product must be sufficiently decomposed (i.e. stable) so that any further decomposition does not adversely affect plant growth (C:N ratio below 25), and contain no toxic or growth inhibiting contaminants.
 - .4 Composed bio-solids to: CCME Guidelines for Compost Quality, Category A.
- .2 Partly Composted Mulch
 - .1 Gro-Bark "Aged Bark Fines" or approved equal.
- .3 Mulch:
 - .1 Wood chips varying in size from 50 mm to 75 mm and 5 to 20 mm thick, free of bark, small branches and leaves.
 - .2 Shredded wood varying in size from 25 to 125 mm in length, from coniferous trees.

- .4 Geotextile: needle-punched, non-woven synthetic fibre fabric, supplied in rolls. Terrafix 270R or equal.
 - .1 Size shall be the largest roll practical for the area to be covered.
 - .2 Composed of: 100% virgin polypropylene fibres.
- .5 Burlap: clean, biodegradable, 2.5 kg/m² minimum mass and 900 mm minimum width.
- .6 Lumber:
 - .1 Plywood for Root Zone Compaction Protection shall be as described above, under "Protection Zone Fencing."
 - .2 Lumber for Root Zone Compaction Protection shall be non-pressure-treated, softwood lumber (finished or unfinished) at the sizes indicated.
- .7 Clear stone shall be in accordance with Section 32 11 23 Aggregate Base Courses
- .8 Steel plates shall be 2400 x 4800 mm or similar steel plates manufactured for use covering trenches or openings under vehicular traffic
- .9 Any other materials required to perform the work of this section shall be new and of the best available quality.
 - .1 Product and manufacturer information for all materials proposed for use must be submitted to the Consultant for review prior to delivery to the site.

PART - 3 EXECUTION

3.1 PROHIBITED ACTIVITIES

- .1 The following are prohibited within protection zones:
 - .1 All construction activities are prohibited.
 - .2 Excavation or alteration of grades.
 - .3 Storage of construction materials, debris, or excavated material.
 - .4 Moving, parking or refuelling vehicles or equipment.
 - .5 Foot traffic (access by Contractor's personnel on foot for maintenance activities is permitted).
 - .6 Erection of sheds or structures.
 - .7 Impoundment of water.
 - .8 Excavation or other digging unless otherwise indicated.
 - .9 Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

3.2 EXAMINATION

- .1 Verification of Conditions: verify that site conditions match the drawings and reports furnished to the Contractor.
 - .1 Inform Owner and Consultant immediately of unexpected conditions.
 - .2 Owner will not entertain costs or delays resulting from Contractor's failure to verify conditions.

3.3 EROSION AND SEDIMENTATION CONTROL:

- .1 Examine the site to verify that temporary erosion- and sedimentation-control measures are in place.
- .2 Verify that flows of water redirected from construction areas or generated by construction activity will not enter or cross protection zones.

- .3 If flows of water are found to enter or cross protection zones, adjust temporary erosion- and sedimentation-control measures to control flows.

3.4 PROTECTION ZONES

- .1 Protection-Zone Fencing shall be accepted by the Consultant and any authority having jurisdiction prior to the commencement of any demolition or excavation works.
 - .1 Protection zone fencing shall not be relocated at any time for any reason without approval of the Owner and any authority having jurisdiction.
- .2 Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones as indicated.
 - .1 Protection-Zone Signage: Install protection-zone signage in visibly prominent locations as detailed.
- .3 Maintain protection zones free of weeds and trash.
- .4 Maintain protection-zone fencing and signage in good condition.
- .5 Remove fencing and signage only when construction operations are complete, equipment has been removed from the site and written authorization has been received from Owner or Consultant.

3.5 ARBORIST SUPERVISION

- .1 The certified arborist shall supervise or personally carry out all indicated works whether within the protection zone or not. These may include but are not limited to the following:
 - .1 Stem Protection.
 - .2 Root zone compaction protection.
 - .3 Cutting or pruning of trees to be preserved.
 - .4 Removal of trees having shared root zones with trees to be preserved.
 - .5 Root-sensitive excavations.
 - .6 Root pruning.
 - .7 Soil decompaction and amendment.

3.6 STEM PROTECTION

- .1 Where indicated, stem protection shall be installed at the same time as the protection zone fencing, prior to any works in the vicinity of the subject trees.
 - .1 Stem protection shall be maintained until the work had been completed and accepted, or earlier if so directed in writing by the Consultant or Owner.
- .2 Stem protection shall consist of:
 - .1 Three layers of burlap continuous from the base of the tree to the height indicated.
 - .2 Continuous 2x4 lumber cladding the stem in a vertical direction to the height indicated and fastened securely with wire.
 - .1 To avoid undesirable pressure on the bark, the lumber members may start above the root flare or they may be made up of shorter lengths or furred-out with pieces of rigid insulation to accommodate irregularly-shaped trunks.

3.7 ROOT ZONE COMPACTION PROTECTION

- .1 Where construction activity is indicated to take place within a protection zone, such activity must be preceded by installation of root zone compaction protection.
- .2 LIGHT ROOT ZONE COMPACTION PROTECTION

- .1 Light Root Zone Compaction Protection is appropriate for non-vehicular access inside a protection zone such as occasional foot traffic, wheelbarrows, etc.
- .2 Light Root Zone Compaction Protection shall consist of:
 - .1 Installation of geotextile over indicated area.
 - .2 Installation of 150 mm depth of mulch spread over the fabric.
 - .3 Installation of continuous 3 mm plywood over the mulch.
- .3 **MODERATE ROOT ZONE COMPACTION PROTECTION**
 - .1 Moderate Root Zone Compaction Protection is appropriate for non-vehicular access in a protection zone such as temporary materials staging.
 - .2 Moderate Root Zone Compaction Protection shall consist of:
 - .1 Installation of geotextile over indicated area.
 - .2 100 mm depth of 20 mm size clear stone spread over the fabric.
 - .3 Installation of medium-weight non-woven geotextile fabric or landscape cloth over the stone.
 - .4 Installation of 150 mm depth of mulch spread over the fabric.
 - .5 Installation of continuous 13 mm plywood over the mulch.
- .4 **HEAVY ROOT ZONE COMPACTION PROTECTION**
 - .1 Heavy Root Zone Compaction Protection is appropriate for occasional vehicular access and long-term materials storage inside the root zone.
 - .2 Heavy Root Zone Compaction Protection shall consist of:
 - .1 Installation of geotextile over indicated area.
 - .2 Installation of 3 stacked and joined courses of 4" x 4" timbers around the area to be protected where loss of material may be expected. (Provide cross-members as required to maintain structural integrity)
 - .3 Installation of 300 mm depth of mulch spread over the fabric.
 - .4 Installation of 2 layers of continuous 13 mm plywood or 1 layer of continuous 13 mm steel plates over the protected area.

3.8 ROOT SENSITIVE EXCAVATION

- .1 Root-sensitive excavation must be conducted in advance of any excavation using conventional excavation machinery.
- .2 Root sensitive excavation shall only be performed by an ISA Certified Arborist using professionally accepted methods.
- .3 Acceptable methods of root-sensitive excavation include hand-digging or pneumatic excavation such as AirSpade. Hydrovac excavation is not acceptable.
 - .1 Excavate trenches 200-300 mm wide and 600 mm apart where indicated.
 - .2 Excavate to a minimum depth of 600 mm, or the maximum depth of excavation for the proposed adjacent works, whichever is greater.
 - .3 Any roots encountered must be properly pruned prior to any adjacent excavation using conventional machinery.
- .4 Post holes within tree root zones must be excavated by root-sensitive methods as described above.

3.9 ROOT PRUNING

- .1 Root pruning shall only be undertaken in conjunction with root-sensitive excavation in advance of conventional excavation, or immediately afterwards if unexpected roots are encountered.
- .2 Root pruning requirements apply only to roots that are severed, exposed, or diseased and are greater than 2.0 cm in diameter should be properly pruned.
- .3 Root pruning shall only be performed by an ISA Certified Arborist using professionally accepted methods.
 - .1 All roots must be pruned with clean and sharp hand tools only. Shovels, or other construction tools shall not be used to prune roots.
 - .2 Roots should be pruned in a similar fashion as branches, taking care to maintain the integrity of the root bark ridge.
 - .3 Roots should be pruned back to native soil; root stubs must not be left upon completion of root pruning.
 - .4 Wound dressings or pruning paint must not be used to cover the ends of any cut.
- .4 All cut roots should be covered with soil or excavated trenches should be backfilled with native material as soon as possible following root pruning. Exposed roots should be covered with soil or mulch and kept moist if they are to be exposed for longer than 3 hours.

3.10 SOIL DE-COMPACTION AND AMENDMENT

- .1 The area to be de-compacted shall be no less than the area shown on the drawings.
- .2 Preparation:
 - .1 Install plywood hoarding or filter fabric attached to portable sectional metal fences to prevent spreading of dust and/or debris beyond the work area.
 - .2 Spread a layer of compost shall be spread to 150 mm depth over the entire area indicated.
- .3 De-Compaction and Amendment
 - .1 De-Compaction and Amendment shall only be performed by an ISA Certified Arborist using professionally accepted methods.
 - .2 Soil is to be de-compacted and amended using pneumatic excavation equipment (e.g., Airspade, Supersonic Air Knife, or approved equal).
 - .1 Set air pressure to 90 psi or as appropriate to prevent penetration of root bark or visible damage to roots larger than fine feeder roots.
 - .3 De-compact where indicated in a grid pattern composed of 300 mm wide air-excavated 'windrows' spaced 600 mm in both directions.
 - .1 Within the windrows, existing soil and composted mulch shall be fully blended to a depth of 300 mm below existing grades.
 - .4 The de-compaction grid shall not encroach within 1000 mm of any tree trunk.
 - .1 Within this area the air excavation equipment nozzle shall be inserted in random locations to effectively loosen soil and incorporate the finished compost soil amendment to a depth of approximately 150 mm below existing grades.
- .4 Following de-compaction and soil amendment, a layer of partly composted mulch shall be spread to a depth of 150 mm over the entire indicated area.

3.11 PRUNING

- .1 Prune all existing trees to the satisfaction of the Consultant.

- .1 Pruning shall include removal of all dead limbs and any preventive maintenance pruning required as a result of adjacent construction works.
- .2 Pruning shall only be performed by an ISA Certified Arborist using professionally accepted methods.
 - .1 Prune heavy bleeders such as birch, maples, lindens and honey locust when in full leaf only (early summer).
 - .2 Maintain the natural form of trees. Dead or diseased limbs are to be cut off flush to the nearest living limb. Leaving small stubs is not acceptable.
 - .3 When necessary, thin out crown of deciduous trees without changing their natural shape or habit.
 - .4 Employ clean, sharp, sterile tools.
 - .1 Pruning saws should be used on limbs 25 mm in diameter or greater.
 - .5 Undercut larger branches to prevent tearing of bark.
 - .6 Make cuts flush with main branch, smooth and sloping to prevent accumulation of water on cut.

3.12 UNINTENDED TREE INJURY

- .1 Where trees are injured during the course of work, the Consultant shall be immediately notified. Injuries requiring notification include the following.
 - .1 Breaking of limbs over 25 mm.
 - .2 Exposure or breaking of roots over 25 mm.
 - .3 Damage to bark.
- .2 Tree injuries shall be inspected by a certified arborist within 24 hours of damage occurring. The arborist's recommendations for remedial work shall be carried out as soon as possible by, or under the supervision of a certified arborist.
 - .1 All works in the vicinity of any injured tree shall be stopped until the required remedial work has been completed.
- .3 All costs or delays associated with injuries to trees shall be the responsibility of the Contractor.
- .4 Compensation:
 - .1 Consultant will report damage or destruction of by-law regulated trees to the authorities having jurisdiction.
 - .1 Contractor will be responsible for costs of any compensation that may be required by the authority.
 - .2 For privately-owned trees, the Contractor is responsible for replacement or compensation as described below, even in the event that the authority having jurisdiction does not require it.
 - .2 Any privately-owned trees intended to remain that are injured or destroyed due to the Contractor's activities shall be replaced with such number of 60 mm size trees as may be required to replace the full caliper size of the tree or trees injured or destroyed.
 - .3 Alternately, trees injured or destroyed may be assessed by the certified Arborist and the Consultant for value of compensation as per the International Arboriculture System of Valuation.
 - .4 Compensation to be paid by the Contractor to Owner.

END OF SECTION 01 56 39.01

1. REFERENCE STANDARDS

- 1.1 Within the individual specifications Sections, reference standards are identified. Conform to these standards, in whole or part, as specifically specified.
- 1.2 Conform to latest date of issue of referenced standards in effect on the date of submission of tenders, except where a date of issue is specifically noted.

2. SPECIFIED PRODUCTS

- 2.1 Work of this Contract is based on Products specified by:

- .1 Manufacturer's catalogued trade names and/or;
- .2 References to standards (i.e. CAN, CGSB, CSA, ASTM) or;
- .3 Prescriptive Specifications or;
- .4 Performance Specifications.

- 2.2 A product identified by one or more manufacturer's trade names is acceptable, and any of the listed products can be used. Products from other manufacturers require approval by the Consultant as equivalent substitutions and must meet the specified substitution criteria.
- 2.3 Multiple trade-named products listed alongside a referenced standard are acceptable, provided they adhere to the referenced standard.
- 2.4 A product specified solely by reference to a standard allows the Contractor to select any product that satisfies or exceeds the standard's requirements for its intended use. The Contractor bears the responsibility of demonstrating compliance with the referenced standard. Products exceeding the minimum requirements of the standard are accepted if they are compatible with the overall Work.
- 2.5 A product specified using prescriptive or performance-based criteria must meet or exceed the specified criteria to be accepted.
- 2.6 For products specified by reference to a standard or through prescriptive or performance criteria, the Contractor must provide a verification report from the manufacturer or an independent testing laboratory upon the Consultant's request, confirming that the product meets or exceeds the required specifications.
- 2.7 Uniformity in manufacturing is required for similar or specific items throughout the Work, unless the Specifications indicate otherwise.

3. PRODUCT AVAILABILITY

- 3.1 Immediately assess material and product delivery requirements and identify any foreseeable supply delays. Inform the Consultant immediately.
- 3.2 Failure to notify the Consultant at the start of the Work may result in the Consultant substituting readily available products of similar quality and character without any increase to the Contract Sum.

4. **SUBSTITUTIONS**

4.1 Requests for substitutions will not be accepted prior to the Notification of Award. Substitutions will be considered by the Consultant provided that:

- .1 Proposed substitutions must be thoroughly investigated, with complete data provided. All aspects meeting the specifications must be clearly highlighted.
- .2 Only complete and detailed data submissions will be reviewed. Incomplete submissions will not be considered.
- .3 Any potential impacts on the Contract Schedule or interactions with other Work must be submitted for review.
- .4 The substitution must carry the same warranty as the originally specified product.
- .5 All claims for additional costs arising from the substitution will be waived.
- .6 Installation of the approved substitution must be coordinated with the overall Work, and full responsibility is assumed for any effects on other work. Any necessary changes to complete the Work must be made by the Contractor.
- .7 The Consultant will revise the drawings to incorporate accepted substitutions, with all associated revision costs borne by the Contractor.

4.2 Substitutions for methods or processes specified in the Specifications or drawings may be proposed to the Consultant for consideration, subject to the following conditions:

- .1 Time spent by the Consultant in evaluating the substitution shall not be the basis for a claim by the Contractor for extensions to the Contract Time.
- .2 Contractor cannot claim extensions to the Contract Time for time spent by the Consultant evaluating the substitution.
- .3 Proposal must clearly demonstrate how the substitution benefits the Owner or improves the operation of the installation as perceived by the Contractor.
- .4 Contractor assumes full responsibility for the substitution and must ensure that warranties for all aspects of the Work remain unaffected.
- .5 Contractor will bear the cost of any necessary changes to the work of Other Contractors resulting from the accepted substitution.
- .6 The substituted methods or processes must fit within the space allocated for the originally specified methods or processes. Any required revisions to the drawings to accommodate the substitution will be made by the Consultant, with all associated costs borne by the Contractor.

4.3 Substitutions will not be considered under the following circumstances:

- .1 They are implied or indicated in shop drawings or Product data without a formal request.
- .2 Their acceptance would necessitate significant revisions to the Specifications and Drawings.

4.4 Do not incorporate substitute Products, methods, or processes into the Work unless the Consultant has expressly approved them for the specific project.

4.5 Approved substituted Products shall be subject to inspection and testing by the Consultant. Installation of such Products may only proceed upon receipt of the Consultant's written approval.

4.6 Contract Price shall be adjusted to reflect any and all credits resulting from the approved substitutions.

5. **APPROVAL OF PRODUCTS AND INSTALLATION METHODS**

5.1 Wherever in the Specifications it is specified that Products and installation methods shall meet the approval of Authorities Having Jurisdiction, Underwriters, the Consultant, or others, such approval shall be provided in writing.

6. **PRODUCT DELIVERY CONTROL**

6.1 It is the responsibility of the Contractor to ensure that the Supplier or Distributor of Materials specified, or Alternatives accepted, which the Contractor intends to use, has Materials available on the Site when required. The Contractor shall obtain confirmed Delivery Dates from the Supplier.

6.2 Contractor shall contact the Consultant immediately upon receiving information indicating that any Material or Item will not be available on time, in accordance with the original Schedule. Similarly, it shall be the responsibility of all Subcontractors and Suppliers to inform the Contractor accordingly.

6.3 Consultant reserves the right to request, at any time, copies of actual Purchase Orders or related documentation for any Materials or Products to be supplied for the Work.

6.4 If Materials and Products have not been placed on order, the Consultant may instruct the Contractor to place such Items on order. If direct communication in writing from the Manufacturer or prime suppliers is not available indicating that Delivery of the Materials will occur in time for the orderly completion of the Work, this directive shall be followed.

6.5 Consultant's review of Purchase Orders or related documentation shall in no way release the Contractor, Subcontractors, or Suppliers from their responsibility for ensuring the timely ordering and necessary expediting of all Materials and Items required to complete the Work as Scheduled and in accordance with the Contract Documents.

6.6 In the event of failure to notify the Consultant at the commencement of the Work, and if it appears that delays may occur due to such failure, the Consultant reserves the right to direct the Contractor to take the following measures at no increase in the Contract Price:

.1 Substitute more readily available Products of similar or better Quality and Character; or

.2 Temporarily install another Product until the specified Product becomes available, at which point the temporarily installed Product shall be removed and the specified Product installed.

7. **TRADEMARKS AND LABELS**

7.1 Permanent Labels, Trademarks, and Nameplates on Products shall not be permitted in the finished Work, except where required by Authorities Having Jurisdiction, for operating instructions, or when located within Service Rooms.

7.2 Such Trademarks and Labels shall be removed by grinding, if necessary, or by painting over where the specific surface is being painted. For plated parts, replace the marked components with new plain plated or non-ferrous metal parts.

8. DELIVERY, STORAGE, HANDLING AND PROTECTION

- 8.1 Contractor is responsible for the handling and delivery of Products. Ensure protection from damage during handling, storage, and installation. Deliver, store, and handle Products in accordance with manufacturer's instructions and Specifications. Costs for delivery, loading, off-loading, and any returns for correction due to damage or defect shall be borne by the Contractor. Reject any damaged materials or Products delivered to the Site.
- 8.2 Products shall be manufactured, packaged, shipped, delivered, and handled to prevent damage to structural qualities, finish appearance, or any aspect detrimental to their function or appearance.
- 8.3 During transportation, ensure Products are not exposed to environmental conditions that may exceed their specified moisture content limits.
- 8.4 Organize the delivery of materials, Products, and equipment to the Site and arrange for the removal of debris and equipment in a manner that minimizes disruption.
- 8.5 Schedule early delivery of Products to avoid delays. Arrange for receiving at the Place of the Work prior to delivery.
- 8.6 Coordinate delivery of mechanical and electrical equipment with manufacturers and suppliers to ensure timely delivery to the Site or suitable storage within the building, protected from weather exposure.
- 8.7 Deliver work prefabricated for ease of handling and to ensure passage through building openings.
- 8.8 Deliver packaged Products in original, unopened packaging with intact seals and labels.
- 8.9 Label packaged Products to indicate contents, quantity, and other required information.
- 8.10 Labels verifying compliance with reference standards will be acceptable as validation of conformity. In the absence of labels, provide affidavits confirming compliance as requested by the Consultant.
- 8.11 Clearly label fire-rated Products to indicate Underwriters' Laboratories approval.
- 8.12 Store and handle materials and Products to prevent damage to the materials, the Work, the Site, or surrounding property.
- 8.13 Ensure local traffic flow is not obstructed or disrupted during the construction period.
- 8.14 Designate an area within the Work limits, approved by the Owner, for Product storage. Maintain this area in an organized and tidy state. Arrange and pay for off-site storage if required.
- 8.15 Store Products on Site to minimize interference with Work and building operations.
- 8.16 Store Products off the ground to prevent damage, adulteration, deterioration, and soiling. Follow manufacturer's storage instructions, where applicable.
- 8.17 Keep packaged or bundled Products in original and undamaged condition, complete with written application instructions, until required for installation.
- 8.18 Do not store materials or Products in corridors, public areas, streets, passageways, or similar locations.

- 8.19 Avoid creating overloading conditions when storing Products within the building or on temporary structures.
- 8.20 Store Products vulnerable to weather in weatherproof enclosures.
- 8.21 Store cementitious materials off the ground and away from walls to prevent contact with moisture.
- 8.22 Keep sand intended for mortar or grout dry and clean. Store sand on raised platforms and cover with waterproof tarpaulins in adverse weather.
- 8.23 Store sheet materials and lumber on flat supports, clear of the ground, and sloped for moisture runoff.
- 8.24 Store flammable liquids and hazardous materials in approved containers per safety authority requirements. Do not store such materials in bulk within the Work.
- 8.25 Designate a secure, ventilated, and heated area for paint storage and mixing. Ensure this area is locked when unattended, and remove combustible debris daily to prevent fire hazards.
- 8.26 Protect prefinished metal surfaces with easily removable coatings or wrappings until final cleanup, ensuring no damage to finishes. Avoid using tapes or coatings that may bake onto the surfaces.
- 8.27 Repair factory-finished surfaces damaged during handling or installation using primer and paint to match the original finish, to the Consultant's satisfaction.
- 8.28 Use adequate shielding to protect glass and other finishes from heat, slag, and weld splatter. Avoid visible markings on exposed or transparent finishes.
- 8.29 Protect exposed surfaces of completed Work from staining, disfigurement, and other damage through restricted access or suitable physical protection methods.
- 8.30 Protect trowelled concrete floors from damage. Take precautions when moving heavy equipment over them.
- 8.31 Keep finished concrete floors free from oils, grease, or materials that could discolor them or affect bonding. Once enclosed, keep floors dry after curing.
- 8.32 Protect finished flooring from pedestrian traffic using reinforced kraft paper, securely taped at joints. Maintain protection until Work is complete.
- 8.33 Protect flooring from ongoing construction and deliveries with 6 mm plywood panels, sealing joints with reinforced tape. Maintain this protection until all construction and deliveries are complete.
- 8.34 Repair or replace damaged materials to the Consultant's satisfaction.
- 8.35 Comply with Workplace Hazardous Materials Information System (WHMIS) regulations for handling, storing, and disposing of hazardous materials. Ensure proper labeling and provide Material Safety Data Sheets (MSDS) to the Consultant for all controlled Products intended for use in the Work.

9. MANUFACTURER'S INSTRUCTIONS

- 9.1 Unless otherwise noted within the Specifications, ensure fabrication, application, connection, installation, erection, use, cleaning, and conditioning of Products align with manufacturer's written instructions, except where more stringent requirements are provided. Avoid reliance on labels or enclosures accompanying the Products and obtain detailed instructions directly from the manufacturer.
- 9.2 Notify the Consultant in writing regarding any discrepancies or conflicts between the Specifications and the manufacturer's instructions. This will allow the Consultant to determine the appropriate course of action. Upon request, provide a copy of the manufacturer's instructions at the site for reference.
- 9.3 In instances where improper installation or erection of Products occurs due to a failure to follow the outlined requirements, the Consultant reserves the authority to mandate the removal and re-installation of such Products at no additional cost to the Contract Price.

10. WORKMANSHIP

- 10.1 Ensure all Workmanship is of the highest quality, performed by workers who are experienced and skilled in their respective duties. Notify the Consultant immediately if the required Work cannot be executed to produce the desired results.
- 10.2 Employ only fit and skilled personnel for the assigned duties. The Consultant retains the right to dismiss from the Place of the Work any worker deemed incompetent, careless, insubordinate, or otherwise unsuitable.
- 10.3 Decisions concerning the quality or suitability of workmanship in the event of disputes shall rest solely with the Consultant, whose decision is final.
- 10.4 Pay close attention to the finished dimensions and elevations of the Work. Ensure the finished Work accurately fits the indicated spaces and that it is flush, plumb, true to lines and levels, and precise in every respect.
- 10.5 Conceal pipes, ducts, conduits, and wiring within floors, walls, ceilings, chases, or behind furring in finished areas, unless specified otherwise.
- 10.6 Position service poles, fill pipes, vents, regulators, meters, and similar installations in discreet locations. Where such locations are not indicated on the drawings, confirm with the Consultant before proceeding with the installation.
- 10.7 Maintain the integrity of fire separations where penetrations occur.
- 10.8 Access panels and doors must match adjacent wall or ceiling finishes unless otherwise specified or indicated in the Contract Documents.
- 10.9 Prepare all surfaces intended for finished materials by ensuring they are free from grease, oil, and other contaminants that could interfere with the application or durability of finish materials.
- 10.10 Implement and enforce fire prevention protocols on-site. Open flames, heating devices, or debris accumulation are strictly prohibited. Use flammable materials only under strict safety precautions. Maintain ULC-labeled fire extinguishers suitable for specific fire hazards in working order and in prominent locations approved by jurisdictional authorities.
- 10.11 For areas involving flammable material application, ensure adequate ventilation, use spark-proof equipment, and strictly prohibit smoking and open flames.

- 10.12 Store packaged or bundled materials and products in their original, undamaged condition, with manufacturer's seals and labels intact. Do not unpackage or unbundle until they are required for the Work.
- 10.13 Sensitive materials and products must be stored in weather-tight, climate-controlled enclosures that provide a favorable environment for their condition and longevity.
- 10.14 Store fabricated products intended for exterior use on sloped supports, elevated above ground level.
- 10.15 Remove and replace damaged materials or products at no additional cost, ensuring the Consultant's satisfaction.
- 10.16 Arrange for off-site storage and protection of products when on-site storage is unavailable. Use impervious sheet coverings for materials prone to deterioration and ensure proper ventilation to prevent condensation or degradation.
- 10.17 Store loose granular materials on solid, flat surfaces in well-drained areas, ensuring they remain uncontaminated by foreign substances.
- 10.18 Provide the necessary equipment and personnel to store materials and products in a manner that prevents soiling, damage, or disfigurement.
- 10.19 Organize storage to facilitate inspection and conduct periodic checks to verify that materials and products remain undamaged and in acceptable condition.
- 10.20 Adequately protect completed or in-progress Work from potential damage. Any Work that becomes damaged or defaced due to inadequate protection must be repaired or replaced as directed by the Consultant, without an increase in the Contract Price.
- 11. **DIMENSIONS**
 - 11.1 Verify all dimensions at the Site prior to commencing fabrication and installation. Report any discrepancies immediately to the Consultant for resolution.
 - 11.2 For dimensions unavailable prior to fabrication, ensure agreement on the required dimensions among all relevant parties before proceeding.
 - 11.3 Confirm that all clearances required by jurisdictional authorities are maintained before commencing Work.
 - 11.4 Wall thicknesses and openings shown on drawings are considered nominal. Ascertain and confirm actual dimensions at the Site before proceeding with related Work.
 - 11.5 Validate dimensions of shop-fabricated portions of the Work at the Site before initiating shop drawings or fabrication. The Owner will reject claims for additional costs arising from failure to comply with this requirement.
 - 11.6 Fabricate and install manufactured, shop-fabricated, and on- or off-site fabricated items to accommodate actual Site dimensions and conditions.
 - 11.7 In areas designated for equipment installation, confirm dimensional data on the equipment to ensure compatibility with provided space, access, and clearance requirements. Ensure all supplied equipment is dimensionally suitable for the allocated space.

- 11.8 Mechanical and electrical drawings are intended to depict approximate locations of apparatus, fixtures, equipment, piping, duct runs, and conduit in diagrammatic form. For items not dimensioned, consider these locations approximate. Review the drawings and consult with the Consultant to confirm actual placements based on aesthetic and site-specific conditions. Relocate as needed without adjustments to the Contract Price.
- 11.9 Maintain clear space where indicated for future equipment installations, ensuring accessibility for such future equipment.
- 11.10 Regardless of the Drawings, provide adequate space and provisions for equipment servicing and for the removal and reinstallation of replaceable components, such as motors, coils, and tubes. Ensure these requirements are incorporated into the Work.
- 12. RELOCATION OF MECHANICAL AND ELECTRICAL ITEMS**
- 12.1 Owner and the Consultant retain the authority to adjust the location of outlets prior to their installation, without incurring additional costs to the Owner, provided that each relocation does not exceed 5000 mm from the originally specified location. No credits will be issued for reductions in materials, products, or labour resulting from relocations within this range.
- 12.2 For relocations exceeding 5000 mm per outlet from the original position, adjustments to the Contract Price will be made in accordance with the provisions outlined in the Contract Documents regarding changes.
- 12.3 Alter the position of pipes and other equipment, without additional cost to the Owner, when such changes are approved and implemented prior to installation.
- 12.4 Ensure all necessary adjustments to accommodate structural and building conditions are completed, with proper approval, at no additional cost to the Owner, addressing any lack of coordination as required.
- 13. CONCEALMENT**
- 13.1 In all finished areas, ensure that pipes, ducts, and wiring are concealed within floors, walls, and ceilings, unless explicitly specified otherwise in the Contract Documents.
- 14. REMEDIAL WORK**
- 14.1 Carry out all remedial tasks necessary to repair or replace any parts or portions of the Work deemed defective or unacceptable. Coordinate with adjacent Work to ensure proper integration and minimal disruption.
- 14.2 Engage specialists experienced with the materials involved to perform remedial tasks. Ensure that the Work is executed in a manner that prevents any damage or risk to other portions of the Work.
- 15. EXPANSION, CONTRACTION, AND DEFLECTION**
- 15.1 Follow the manufacturer's recommended installation temperatures. When items, components, assemblies, systems, and finishes are installed at temperatures differing from their operation or service temperatures, provide provisions for expansion and contraction as approved by the manufacturer and Consultant. Repair any damage caused by inadequate provisions for expansion and contraction.

- 15.2 Account for expansion and contraction due to temperature fluctuations within components, Products, and assemblies, as well as between adjacent components, Products, and assemblies. Consider building movements such as creep, column shortening, deflection, sway, and twist to ensure no damage occurs to or within these elements.
- 15.3 Allow sufficient clearance at wall and partition heads to accommodate structural deflection. Obtain specific requirements from the Consultant where further clarification is needed. When partitions meet the underside of floor assemblies or structural framing, ensure clearances are determined based on the span of the supporting structural members. Maintain the integrity of walls and partitions as sound and/or fire barriers by using appropriate methods.
- 15.4 Incorporate provisions in pipes, plenums, ducts, and vessels containing air and fluids to prevent damage from pressure, surges, and vibrations. Ensure these provisions protect pipes, plenums, ducts, and vessels, as well as adjacent components, assemblies, and construction through which they are attached or pass.
16. **DIELECTRIC SEPARATION**
- 16.1 Provide a permanent dielectric separator over all contact surfaces between dissimilar materials to prevent electrolytic action (galvanic corrosion).
- 16.2 Ensure aluminum is protected from corrosion when in contact with alkaline materials, such as those found in cementitious products, by implementing appropriate preventive measures.
17. **PRODUCTS AT SOUND ATTENUATING PARTITIONS**
- 17.1 Prevent sound transfer at sound-attenuating partitions by ensuring precise placement and treatment of mechanical and electrical components, including ducts, grilles, diffusers, electrical outlets, and boxes.
- 17.2 When electrical boxes serve both sides of a partition and are placed back-to-back, ensure a minimum lateral separation of 300 mm.
- 17.3 Use flexible connections for interconnected electrical boxes to further minimize sound transfer.
18. **FASTENINGS**
- 18.1 Provide metal fastenings and accessories matching the material, texture, color, sheen, and finish of adjacent materials unless otherwise indicated.
- 18.2 Ensure prevention of electrolytic action between dissimilar metals and materials.
- 18.3 Utilize non-corrosive hot-dip galvanized steel fasteners and anchors for securing exterior Work unless stainless steel or an alternative material is specified in the applicable Specification Section. Leave steel anchors bare where cast in concrete.
- 18.4 Include all required fastenings, anchors, inserts, attachment accessories, and adhesives in each Section's Work. Deliver and locate devices in ample time for installation where required in other Sections.
- 18.5 Avoid using fiber, plastic, or wood plugs or blocking for fastenings in masonry, concrete, or metal construction unless specifically specified or shown on Drawings
- 18.6 Install fastenings or adhesives in sufficient quantities to ensure permanent, secure anchorage under static conditions. Fastenings must withstand building thermal movement, creep, and vibration.

- 18.7 Conceal fasteners where indicated. Minimize the use of exposed fastenings, ensuring they are spaced evenly and arranged in an organized, symmetrical pattern.
- 18.8 Ensure fastenings do not cause spalling or cracking of the material to which anchorage is made.
- 18.9 Powder Actuated Fastenings:
- .1 Prohibit the use of powder-actuated fasteners for ceiling support.
- .2 Do not utilize powder-actuated fastenings in any portion of the Work unless written consent for a specific application is provided by the Consultant.
- .3 Only low-velocity tools are permissible. Operators must be qualified and possess a valid operator's certificate.

19. **ADJUSTING**

- 19.1 Ensure that all components of assemblies fit snugly, align accurately, and remain in true planes, with all moving parts operating freely without binding or scraping.
- 19.2 Verify the proper functioning of all Work and make necessary adjustments to ensure optimal performance.
- 19.3 Lubricate Products as recommended by the manufacturer to maintain smooth operation.

20. **MANUFACTURERS' INSTRUCTIONS**

- 20.1 Unless otherwise stated in the Specifications, install or erect materials and Products in strict accordance with the manufacturers' instructions.
- 20.2 Failure to comply with these requirements, resulting in improper installation or erection, authorizes the Consultant to mandate removal and reinstallation at no increase in the Contract Price.

21. **OVERLOADING**

- 21.1 Prevent overloading of any portion of the building.
- 21.2 Avoid cutting, drilling, or sleeving load-bearing structural members unless explicitly detailed in the Contract Documents and approved in writing by the Consultant.

22. **EXISTING UTILITIES**

- 22.1 Perform Work involving breaking into or connecting to existing utilities or services at times specified by local authorities, minimizing disruption to pedestrian and vehicular traffic.
- 22.2 Protect, relocate, or maintain active services encountered during the Work.
- 22.3 Cap off inactive services in a manner approved by the authority having jurisdiction, ensuring proper staking and recording of the capped service's location.

END OF SECTION

1. **DEMONSTRATION AND INSPECTION OF PRODUCTS AND SYSTEMS**

- 1.1 Arrange for a full demonstration of systems and operational Products upon completing 100% of their installation and prior to certification of Substantial Performance.
- 1.2 Include arrangements for the attendance of the Consultant, Owner, jurisdictional authorities, and personnel designated by the Owner to operate the systems and/or Products.
- 1.3 Conduct demonstrations by the Subcontractor responsible for the system and/or Product installation, with assistance from manufacturer or supplier representatives. Personnel conducting the demonstration shall possess complete knowledge of all operational, functional, and maintenance requirements of the systems and/or Products.
- 1.4 Obtain acknowledgment from the Owner's representative of the successful completion of each demonstration on a form provided by the Contractor. This form shall be agreed upon by the Owner, Consultant, and Contractor before demonstration and testing.
- 1.5 Submit letters from manufacturers of systems and/or Products prior to applying for a certificate of Substantial Performance. These letters shall verify that the Products are correctly installed, connected, and operating satisfactorily. Certification shall be based on inspections and testing conducted by qualified technical personnel and include the names of personnel, methods of inspection, and locations of the certified Products within the building.
- 1.6 Following submission and acceptance of certification letters, grant the Owner the right to use the Products on a trial basis and for instructing their personnel in their use.

2. **FINAL INSPECTIONS AND CLOSEOUT**

- 2.1 Submit proposed closeout procedures and an inspection schedule to the Consultant for approval before initiating final demonstrations and inspections.
- 2.2 Provide layout and survey documentation required by the Owner and jurisdictional authorities.
- 2.3 Arrange, conduct, and document final demonstrations, inspections, closeout, and take-over procedures upon Work completion, adhering to OAA/OGCA TAKE-OVER PROCEDURES as outlined in OAA/OGCA Document No. 100.

- .1 For the purposes of Document No. 100, references to "Architect" shall be understood as "Consultant."

3. **CERTIFICATE OF COMPLIANCE**

- 3.1 Prior to applying for Substantial Performance, submit Certificates of Compliance for the following items.
- 3.2 An affidavit confirming the use of lead-free solder for all domestic water lines.
- 3.3 Products accompanied by accepted Material Safety Data Sheets (MSDS).
- 3.4 Any other Work or Products identified in the Contract Documents as requiring a Certificate of Compliance.
- 3.5 Certificates of Compliance shall include:

- .1 Names and addresses of the project and the Owner.
- .2 Date of issue.
- .3 Detailed product description, including name, number, and manufacturer.
- .4 A statement verifying that the installed Work/Product meets specified requirements and complies with accepted MSDS, when applicable.
- .5 Each Certificate of Compliance shall be issued on the Subcontractor's letterhead, properly executed, under whose scope the Work/Product was provided.
- .6 The Contractor shall endorse each Certificate of Compliance with their authorized stamp/signature. Submissions must allow sufficient time for review to prevent delays in scheduled completion.

3.6 FINAL CLEANING

- .1 Refer to SECTION 01 74 00 "Cleaning".

3.7 PROJECT CLOSEOUT SUBMITTALS

- .1 Prior to application for Certificate of Substantial Performance, submit the following documents in accordance with the requirements of the Contract Documents:
 - .2 Project Record Documents: Refer to SECTION 01 78 23.
 - .3 Operation and Maintenance Manual: Refer to SECTION 01 78 23.
 - .1 Complete set of warranties and maintenance service agreements: Refer to SECTION 01 78 23.
 - .2 Complete set of final shop drawings: Refer to SECTION 01 33 00.
 - .4 Spare Parts and Maintenance Materials: Refer to SECTION 01 78 23.
 - .5 The Certificate of Substantial Performance will not be issued until the above documents have been submitted and are deemed by the Consultant to be acceptable.

END OF SECTION

1. FIELD ENGINEERING

- 1.1 The Contractor assumes responsibility for all survey and field engineering Work required for the Project.
- 1.2 Engage a Registered Ontario Land Surveyor, approved by the Owner, to perform all field engineering tasks.
- 1.3 Records
 - .1 Maintain an accurate and comprehensive log of control and survey Work as it progresses.
 - .2 Upon foundation completion, prepare a certified survey outlining dimensions, locations, angles, and elevations of the Work.
 - .3 Submit a certificate, signed by the Surveyor, verifying that completed Work aligns with, or deviates from, the Contract Documents.

2. LAYOUT AND SURVEY

- 2.1 Existing grades, lines, and site conditions shown on the drawings are based on survey data established by personnel directly engaged by the Owner. The Consultant assumes no responsibility for the accuracy of this survey information. The Contractor shall establish the location of property lines.
- 2.2 Contractor is responsible for setting out the Work. Before commencing, verify dimensions and elevations indicated in the Contract Documents and notify the Consultant of any unsatisfactory conditions that may impede the proper completion of the Work.
- 2.3 Establish and maintain permanent reference points, ensuring their accuracy throughout the duration of the project. Set lines and levels required for the execution of the Work.
- 2.4 Accurately set out the Work using established levels and lines. For any Work that depends on grades and elevations of existing structures or facilities, prioritize the existing conditions over reference elevations. Notify the Consultant of any discrepancies.
- 2.5 Engage a licensed Land Surveyor, certified to practice in the place of Work, to perform layout and verification of the following project elements:
 - .1 Lay out the building addition on the site.
 - .2 Establish a permanent benchmark or widely separated markers.
 - .3 Set and maintain temporary benchmarks in appropriate locations.
 - .4 Provide general dimensions, lines, and elevations required by Subcontractors.
 - .5 Establish lines and levels, and conduct location and layout by instrumentation.
 - .6 Stake batter boards for foundations.
 - .7 Establish foundation, column locations, and floor elevations.
 - .8 Establish lines and levels for mechanical and electrical Work.

- .9 Verify elevations of floor and roof levels as construction progresses, ensuring consistency with benchmark datum.
 - .10 Confirm elevations of finished floors at connections between existing buildings and additions.
 - .11 Ensure that construction on the site does not violate current or anticipated restrictions, including lines of traverse to public utilities.
 - .12 Align geodetic elevation of benchmark datum with elevations used by adjacent public utilities.
 - .13 Verify the accuracy of site dimensions shown on the drawings.
 - .14 Conduct a survey to confirm footing locations adjacent to property lines before footing construction begins.
 - .15 Survey the building location relative to property lines once foundation walls are completed to grade level.
 - .16 Survey asphalt and concrete paving areas prior to placement to confirm conformance with grades indicated on the drawings.
 - .17 Provide a final survey to verify the completed building's location on the site.
- 2.6 Protect and preserve established benchmarks throughout the project. Should a benchmark be lost or displaced, re-establish it using a licensed Land Surveyor at no additional cost to the Owner. Assume full responsibility for setting out the Work.
- 2.7 In the event of a discrepancy regarding horizontal or vertical alignment conditions exceeding allowable tolerances, the Owner may engage an independent Land Surveyor to investigate. The determination of responsibility and associated costs for this service, whether borne by the Owner or Contractor, will depend on the investigation's findings.
- 2.8 All costs incurred to correct conditions resulting from errors made by the Contractor shall be borne by the Contractor.
3. **DIMENSIONS**
- 3.1 Verify and check all dimensions related to the Work. Dimensions that pertain to other Sections must be confirmed with the relevant Section. On-site measurements are required for Work that must align or conform with previously installed Work.
- 3.2 Avoid scaling drawings. Consult the Consultant immediately to resolve ambiguities, lack of information, or inconsistencies. The Contractor bears responsibility for extra costs resulting from non-compliance with this requirement.
4. **EXISTING UTILITIES**
- 4.1 The Contractor is responsible for gathering all necessary information regarding sewer, gas, water, telephone, electrical signal systems, and any other utilities within the building or surrounding locations.
- 4.2 Protect piping, sewer lines, conduit, and similar utilities owned by others during construction activities.
5. **EXAMINATION**

- 5.1 Inspect areas and conditions where Work is to be performed. Notify the Consultant in writing of conditions that may hinder proper and timely completion of the Work.
- 5.2 Confirm that existing site conditions and substrate surfaces are suitable for subsequent Work.
- 5.3 Verify the structural capability of existing substrates to support or attach new Work.
- 5.4 Confirm specific conditions as detailed in individual Specification Sections.
- 5.5 Ensure utility services are available, possess the correct characteristics, and are located appropriately.
- 5.6 Do not commence Work until all unsatisfactory conditions are corrected to the installer's satisfaction.
- 5.7 Starting installation implies acceptance of the site conditions.
- 6. **PREPARATION**
- 6.1 Clean substrate surfaces thoroughly before applying any subsequent material or substance.
- 6.2 Allow substrate surfaces to cure or dry to moisture content limits specified by the manufacturer of the material or substance to be applied.
- 6.3 Seal cracks and openings in the substrate before applying subsequent materials or substances.
- 6.4 Apply the primer, sealer, or conditioner recommended or required by the manufacturer to the substrate before adding new materials or substances.

END OF SECTION

1. **WORKMANSHIP**

- 1.1 Ensure all Workmanship is executed by experienced and skilled workers for their respective duties. Notify the Consultant immediately when required Work conditions make achieving the required results impractical.
- 1.2 Do not employ unfit personnel or individuals unskilled in their designated duties.
- 1.3 In case of disputes, the Consultant will decide on the quality or fitness of Workmanship, and their decision shall be final.

2. **CONCEALMENT**

- 2.1 Conceal pipes, ducts, and wiring within floors, walls, and ceilings in finished areas unless specified otherwise.
- 2.2 Notify the Consultant prior to installation when contradictions arise, and proceed with installation as directed by the Consultant.

3. **LOCATION OF FIXTURES**

- 3.1 Treat fixture, apparatus, equipment, fittings, outlets, conduits, pipes, and duct locations shown or specified without dimensions as approximate.
- 3.2 Seek clarification from the Consultant to establish precise locations. Any relocations due to lack of clarification requests will be completed by the Contractor at no additional cost.
- 3.3 Coordinate Work across Sections to conserve space and ensure ducts, pipes, and conduits fit within designated wall and ceiling spaces.
- 3.4 Install exposed ducts, piping, and conduits neatly and uniformly parallel to building lines and one another. Obtain Consultant's review before proceeding. Alter installations not conforming to the Consultant's review at no additional cost.
- 3.5 Organize exposed mechanical and electrical installations, such as outlets, switches, and panels, orderly and neatly. Secure the Consultant's review of proposed layouts before rough-in Work begins. Make relocations as needed, without extra cost, where prior review was not requested.

4. **REMOVED MATERIAL**

- 4.1 Materials marked for removal, unless specified otherwise, become the Contractor's property and must be removed from the Site.
- 4.2 Deposit unsalvageable materials in designated garbage containers daily or as directed by the Consultant.
- 4.3 Obtain Consultant's approval for garbage container placement.
- 4.4 Remove containers as soon as they are full and dispose of contents legally.

5. **CONSTRUCTION SAFETY REQUIREMENTS**

- 5.1 Execute all Work in full compliance with the construction health and safety requirements outlined in Section 01 35 29, "Health and Safety Requirements."

6. POWDER ACTUATED FASTENING DEVICES

- 6.1 Do not use powder-actuated tools employing explosives unless explicitly permitted by the Consultant. Comply with CAN3-Z166.2-M85, "Use and Handling of Powder Actuated Tools."
SLEEVES, HANGERS, AND INSERTS

7. SLEEVES, HANGERS, AND INSERTS

- 7.1 Coordinate the placement of sleeves and the installation of hangers and inserts. Obtain the Consultant's approval before proceeding.

END OF SECTION

1. GENERAL

- 1.1 Provide all necessary labour, Products, equipment, services, tools, and supervision to perform cutting and patching Work in strict compliance with the Contract Documents.
- 1.2 Obtain the Consultant's approval before performing any cutting, boring, or sleeving of load-bearing members.

2. DEFINITIONS

- 2.1 The terms “make good,” “making good,” “made good,” “restore to existing,” “patch,” “repair,” and similar phrases, unless context specifies otherwise, are defined as.
 - .1 Restoring materials and finishes damaged or disturbed during additions or reconstruction to their original condition.
 - .2 Matching new Work to existing materials, form, construction, and finish unless otherwise specified.
 - .3 Ensuring no visible differences in appearance between existing and new Work, discernible by the naked eye from a distance of 3 metres, and achieving equivalent performance characteristics.

3. SUBMITTALS

- 3.1 Submit a written request before performing any cutting or alteration affecting:
 - .1 Structural integrity of the Structure or Contract.
 - .2 Integrity of weather-exposed or moisture-resistant elements.
 - .3 Efficiency, maintenance, or safety of operational elements.
 - .4 Visual qualities of sight-exposed elements.
 - .5 Work of the Owner or Other Contractors.
- 3.2 Include in the submission:
 - .1 Identification of the Contract.
 - .2 Location and description of the affected Work.
 - .3 Statement of the necessity for cutting or alteration.
 - .4 Detailed description of the proposed method and materials.
 - .5 Alternatives to cutting and patching.
 - .6 Impact on Work of the Owner or Other Contractors.
 - .7 Proposed date and time for execution.
- 3.3 Obtain the Consultant's approval of the proposed cutting method before commencing Work.

4. INSPECTION

- 4.1 Thoroughly examine existing conditions, including elements susceptible to damage or movement during cutting and patching activities.
- 4.2 Upon uncovering, assess conditions that may influence the performance of the Work.
- 4.3 Commencement of cutting or patching Work will be deemed as acceptance of the existing conditions.

5. PRODUCTS

- 5.1 Use Products of the same or better quality than those originally installed.

6. PREPARATION

- 6.1 Inspect existing conditions to identify elements subject to damage or movement during cutting and patching.
- 6.2 After uncovering, inspect conditions impacting the performance of the Work.
- 6.3 Commencement of cutting or patching Work signifies acceptance of existing conditions.
- 6.4 Ensure the structural integrity of surroundings through proper support systems and protect adjacent areas from damage.
- 6.5 Protect exposed areas from elements during uncovering, ensuring excavations remain dry.

7. EXECUTION

- 7.1 Perform Work carefully to prevent damage to other areas or elements.
- 7.2 Complete cutting, fitting, and patching, including excavation and filling, to achieve a professional finish.
- 7.3 Employ skilled labour appropriate for the type of cutting Work being performed.
- 7.4 Integrate Work segments seamlessly, accommodating penetrations through surfaces.
- 7.5 Remove and replace defective or non-conforming Work.
- 7.6 Ensure all drilling, cutting, fitting, patching, and finishing is executed professionally and creates watertight connections with adjoining structures.
- 7.7 Provide openings in non-structural elements for mechanical and electrical penetrations.
- 7.8 Use methods to avoid damage to other Work and create appropriate surfaces for patching and finishing.
- 7.9 Employ proper equipment for cutting. For rigid materials, use masonry saws or core drills. Avoid pneumatic or impact tools on masonry without prior approval.

- 7.10 Match new Work to existing structures by cutting, patching, and making good with materials that replicate the original condition.
- 7.11 Ensure proper formation and bridging of masonry and structural wall openings.
- 7.12 Guarantee compatibility and secure installation of all Products.
- 7.13 Restore Work with new Products that meet Contract Document requirements.
- 7.14 Create airtight seals for penetrations through pipes, sleeves, ducts, and conduits.
- 7.15 Prepare surfaces appropriately to receive patching and finishing materials.
- 7.16 Refinish surfaces to match adjacent finishes. For continuous surfaces, extend refinishing to the nearest intersection. For assemblies, refinish the entire unit.

END OF SECTION

1. GENERAL

- 1.1 Ensure the assigned Work areas are kept clean and maintained in an orderly condition to the satisfaction of the Consultant.
- 1.2 Regularly remove rubbish and waste materials from the Work areas, or as directed by the Consultant.
- 1.3 Burning or burying of rubbish and waste materials on-site is strictly prohibited.
- 1.4 Use only cleaning materials specifically recommended by the manufacturer for the surface being cleaned.
- 1.5 Apply cleaning materials only on surfaces for which they are explicitly approved by the cleaning material manufacturer.

2. CLEANING DURING CONSTRUCTION

- 2.1 Remove spatters, droppings, soil, labels, and debris from finished Work promptly before they harden or set.
- 2.2 Use only cleaning materials recommended by both the manufacturer of the surface to be cleaned and the manufacturer of the cleaning material.
- 2.3 Maintain Work areas "broom clean" daily and ensure they are cleaned immediately before starting any finishing work.
- 2.4 Burning or burying of waste materials on-site is strictly prohibited. Remove waste materials and debris as frequently as needed to prevent accumulation, and no less than at the end of each working day.
- 2.5 Immediately remove packaging materials and debris from the site after unwrapping or uncrating products and equipment.
- 2.6 Volatile fluid wastes shall not be disposed of in storm or sanitary sewers, open drain courses, or anywhere on the site.
- 2.7 Prevent waste material and debris from accumulating in an unsightly or hazardous manner. Sprinkle dusty areas with water as necessary. Provide containers for collecting waste and debris, and ensure hazardous products are disposed of in compliance with jurisdictional authority requirements.
- 2.8 Adhere to the Regulatory Requirements article in Quality Requirements, Section 01 40 00.
- 2.9 Schedule cleaning operations to prevent dust or foreign matter from settling on surfaces during finishing work and until tacky or wet finishes are completely cured.
- 2.10 Include final cleaning instructions for finishing Work in the Maintenance and Operating Manuals.
- 2.11 Maintain Work areas free of waste products, packaging, and debris.

- 2.12 Deposit waste material, packaging, and debris into designated waste containers at the end of each working day, or more frequently, as required.
- 2.13 Control dust and dirt levels to meet acceptable standards, as directed by the Consultant.
- 2.14 Remove oily rags, waste, and hazardous substances from the premises daily or more frequently, as necessary.
- 2.15 Arrange and obtain necessary permits for debris disposal from the relevant authorities.
- 2.16 Perform cleanup promptly upon receiving verbal or written instructions from the Consultant.
- 3. **FINAL CLEANING**
- 3.1 Prior to Substantial Performance, remove all surplus Products, tools, construction machinery, and equipment not required for the remaining Work.
- 3.2 Eliminate stains, dirt, and smudges from all finished surfaces.
- 3.3 Clean exposed finished surfaces as per the recommendations provided by respective material manufacturers.
- 3.4 Polish and clean glass, mirrors, hardware, wall tiles, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace any glass that is broken, scratched, or otherwise disfigured.
- 3.5 Remove all stains, spots, marks, and dirt from decorative elements, electrical and mechanical fixtures, furniture fitments, walls, floors, and other surfaces.
- 3.6 Thoroughly vacuum and dust building interiors, including spaces behind grilles, louvers, and screens.
- 3.7 Wax, seal, shampoo, or prepare floor finishes as per manufacturer recommendations.
- 3.8 Inspect all finishes, fitments, and equipment to ensure compliance with specified workmanship and operational standards.
- 3.9 Broom-clean and wash exterior walkways, steps, and other surfaces.
- 3.10 Remove dirt and any disfiguration from exterior surfaces.
- 3.11 Clean and sweep roofs, gutters, areaways, and sunken wells.
- 3.12 Sweep and wash all paved exterior areas.
- 3.13 Clean mechanical and electrical fixtures, removing all labels, wrappings, paper, and other foreign materials.
- 3.14 Replace heating, ventilation, and air conditioning filters if units were operated during construction.
- 3.15 Clean ducts, blowers, and coils in cases where HVAC systems were operated without filters during construction.

- 3.16 Clean all roofs, downspouts, and drainage systems to ensure proper functioning.
- 3.17 Upon Total Performance of the Work, remove all surplus Products, tools, construction machinery, equipment, waste Products, and debris.
- 4. Additional Final Cleaning Requirements:
 - 4.1 Replace any damaged or defective glass and mirrors before final inspection.
 - 4.2 Engage skilled cleaning specialists for final cleaning upon construction completion.
 - 4.3 Remove all temporary protections and correct defects prior to the start of final cleaning operations.
 - 4.4 Perform final cleaning to remove dust, stains, paint spots, soil, grease, fingerprints, and accumulations of construction materials, both interior and exterior, across all new and existing building areas. Cleaning methods shall comply with manufacturer instructions for each material.
- 5. Scope of Final Cleaning Work:
 - 5.1 Wash exterior paved surfaces and clean interior stone, brick, and concrete floors.
 - 5.2 Clean and polish glass, mirrors, porcelain, enamel, and finished metals.
 - 5.3 Vacuum ceilings, walls, and floors thoroughly.
 - 5.4 Clean and polish ceramic and quarry tile floors.
 - 5.5 Clean resilient flooring and buff it with two light coats of wax as recommended by the flooring manufacturer, each coat buffed to finish.
 - 5.6 Wash glazed wall surfaces to remove any residual construction materials.
 - 5.7 Clean hardware, mechanical fixtures, plumbing fixtures, lighting fixtures, cover plates, and equipment, polishing all metal, porcelain, vitreous, and glass finishes.
 - 5.8 Clean windows, entrances, and skylights, ensuring all interior and exterior surfaces are spotless.
- 6. Maintain the cleanliness of the building and its premises until the Owner assumes possession of the building or its portions.

END OF SECTION

1. **REFERENCES**

- 1.1 European Commission Waste Framework Directive 2008/98/EC
- 1.2 Industrial Emissions Directive (IED) 2010/75/EU
- 1.3 EN 303 Series Standards for heating boilers and other relevant equipment

2. **DEFINITIONS**

- 2.1 Alternative Daily Cover: Material (other than earthen material) that is placed on the surface of the active face of municipal solid waste landfills at the end of each operating day to control vectors, fires, odours, blowing litter, and scavenging.
- 2.2 Biomass: Plant material from trees, grasses, or crops that can be converted to heat energy to produce electricity.
- 2.3 Construction and Demolition Debris: Includes waste and recyclables generated from construction and from the renovation, demolition, or deconstruction of pre-existing structures. It does not include hazardous materials or land-clearing debris, such as soil, vegetation, and rocks.
- 2.4 Construction Waste Calculation: Used to determine the percentage of waste diverted from landfill and incineration facilities on a metric tonne basis.
- 2.5 Construction Waste Management Plan: A document specific to a building project that outlines measures and procedures that divert construction waste materials from landfill and incineration facilities. It describes specific end use locations and purposes for the material diverted.
- 2.6 Construction Waste Management Summary Spreadsheet: A spreadsheet used to track waybill information provided by all of the construction / demolition waste haulers used on the project.
- 2.7 Eligible Biofuels: Untreated wood waste, agricultural crops or waste, landfill gas, animal waste and other organic waste.
- 2.8 Hazardous Materials: As defined by relevant regulations in the location of the project. Hazardous materials should be excluded from calculations and should be disposed of according to relevant regulations.
- 2.9 Incineration Facilities: Waste management operations that use combustion as a means of reducing the volume of waste materials.
- 2.10 Recycling: The collection, reprocessing, marketing, and use of materials that were diverted or recovered from the solid waste stream.
- 2.11 Reuse: The return of materials to active use in the same or a related capacity as their original use, thus extending the lifetime of materials that would otherwise be discarded.
- 2.12 Tipping Fees: Charged by a landfill for disposal of waste, typically quoted per tonne.

3. **SUBMITTALS**

- 3.1 **Construction and Demolition Waste Management (CWM) Plan**

- .1 Provide an electronic copy to the Consultant for review before waste removal.
- .2 Include at least five materials targeted for diversion.
- .3 Outline on-site/off-site diversion strategies.
- .4 Ensure compliance with European directives and EN 303 standards for waste-to-energy systems.
- .5 Obtain Consultant approval prior to waste removal.

3.2 **Monthly Submissions**

- .1 Submit a tracking spreadsheet with waybill details, including bin weights and material composition.
- .2 Provide monthly diversion rates for commingled waste, categorized by weight or volume.

3.3 **Close-Out Submittals**

- .1 Submit a certified letter confirming cessation of waste removal from the project site.
- .2 Provide completed waste diversion calculations and supporting documentation for Consultant review.

4. **EXECUTION**

4.1 **Diversion of Materials**

- .1 Recycle and salvage non-hazardous construction and demolition debris.
- .2 Prevent contamination of reusable and recyclable materials.

4.2 **Construction Waste Calculations**

- .1 Convert all waste documentation to weight (metric tonnes).
- .2 Provide defensible conversion metrics for estimating weights.
- .3 Include salvaged materials such as furniture, fixtures, and construction debris in calculations.
- .4 Exclude soil, rocks, and hazardous materials from waste diversion calculations.

4.3 **Material Sorting and Separation**

- .1 Separate materials from general waste streams into designated containers.
- .2 Ensure commingled waste facilities provide project-specific diversion rates based on measured components.

4.4 **On-Site Implementation**

- .1 Designate on-site recycling locations.

.2 Educate subcontractors about recycling requirements.

.3 Maintain a hard copy of the Construction Waste Management Plan on-site.

4.5 **Waste Diversion Goals**

.1 Divert 75% or more waste from four or more material streams, including concrete, asphalt, rubble, cardboard, metals, and gypsum board.

4.6 **Collaboration with Manufacturers**

.1 Minimize packaging waste and coordinate pallet reclamation efforts.

4.7 **Final Documentation**

.1 Ensure accurate and complete tracking of all diverted and disposed materials.

.2 Provide certified waste management summaries for project close-out.

END OF SECTION

1. **INSPECTION AND DECLARATION PROCEDURES**
 - 1.1 Follow the recommended procedures concerning substantial performance of construction contracts and completion take-over of projects as prescribed in OAA/OGCA Document 100 "Take Over Procedures".
2. **REINSPECTION**
 - 2.1 Should the status of the Work necessitate reinspection by the Consultant due to the failure of the Work to comply with the Contract Documents, the Owner shall deduct the costs associated with reinspection services from the payment due to the Contractor.
3. **FINAL CLEANING**
 - 3.1 Refer to SECTION 01 74 00 "Cleaning".
4. **ADJUSTING**
 - 4.1 Adjust operating products and equipment to ensure smooth and unhindered operation.
5. **PROJECT CLOSEOUT SUBMITTALS**
 - 5.1 Prior to application for Certificate of Substantial Performance, submit the following documents in accordance with the requirements of the Contract Documents:
 - .1 Project Record Documents: Refer to SECTION 01 78 23.
 - .2 Operation and Maintenance Manual: Refer to SECTION 01 78 23. Include:
 - .1 Complete set of warranties and maintenance service agreements: Refer to SECTION 01 78 00.
 - .2 Complete set of final shop drawings: Refer to SECTION 01 33 00.
 - .3 Spare Parts and Maintenance Materials: Refer to SECTION 01 78 23.
 - .4 The Certificate of Substantial Performance will not be issued until the above documents have been submitted and are deemed by the Consultant to be acceptable.

END OF SECTION

1. **GENERAL**

- 1.1 Provide two (2) copies of a comprehensive Operations and Maintenance Manual to the Consultant, containing material suitable for the Owner's maintenance staff. Manuals shall include all Products supplied and installed under the Contract.
- 1.2 Submit a draft version of the Operations and Maintenance Manuals for the Consultant's review at least 2 weeks before testing systems and equipment. Incorporate any alterations and additions identified during the review process and testing, and prepare the final version of the manual based on the corrected draft.
- 1.3 Submit the final version of the Operations and Maintenance Manuals before Contract Completion.
- 1.4 Testing of systems and equipment will not be considered complete until the Consultant has received the requisite number of copies of the finalized manuals.
- 1.5 Remove irrelevant information from standard literature included in the Operations and Maintenance Manual, or clearly mark such sections as not applicable.
- 1.6 Ensure that the manuals contain sufficient detail to enable the Owner to fully maintain the equipment without the need for external assistance.
- 1.7 All submitted materials must be in English.

2. **FORMAT**

- 2.1 Organize all data into a clear and comprehensive instructional manual format.
- 2.2 Use commercial-quality binders, sized 219 x 279 mm, with a maximum "D" ring size for durability and usability.
- 2.3 When multiple binders are required, ensure data is grouped into related and consistent categories.
- 2.4 Label each binder with the printed title "Contract Record Documents," including the title of the Contract and an identifier for the subject matter within.
- 2.5 Organize the content by systems or process flow, aligned with the sequence and section numbers in the Table of Contents.
- 2.6 Include a tabbed fly leaf for each separate Product and system, containing a typed description of the Product and major component parts of the equipment.
- 2.7 Provide a tabbed fly leaf for Products and systems supplied by the Owner but installed under the Contract, clearly distinguishing them.
- 2.8 Use the manufacturer's printed data or typewritten information on 20-pound paper for consistency and readability.
- 2.9 Include drawings with reinforced punched binder tabs. Bind these drawings alongside the text, folding larger drawings to match the size of the text pages for ease of use.

2.10 CONTENTS

- .1 Operation and maintenance manuals shall include the following minimum information and data:
- .2 Table of contents: Provide the title of the Contract, names, addresses, and telephone numbers of Consultants and Contractor, along with the name of responsible parties. Include a schedule of Products and systems, indexed to the content of the volume.
- .3 For each Product or system: List the names, addresses, and telephone numbers of Subcontractors, suppliers, and service representatives. Include local sources of replacement supplies and parts with telephone numbers.
- .4 Warranties: Warranties are between the Contractor and Owner and shall include:
 - .1 Description of warranty coverage.
 - .2 Date warranty starts, being the date of Contract Completion.
 - .3 Date warranty expires.
 - .4 Contact name, address, and phone number (Contractor shall notify the Owner of any changes to contact information during the warranty period).
 - .5 Equipment and components performance curves.
 - .6 Hydro certificates.
- .5 Reports: Provide the following for each Product or system:
 - .1 Manufacturer's certified reports.
 - .2 Factory test reports.
 - .3 Field testing reports.
- .6 Design, construction, and/or fabrication details: Include features, component functions, and maintenance requirements to support effective start-up, operation, maintenance, repair, modification, extension, and expansion of installations.
- .7 Technical data: Include Product data, bulletins, component illustrations, detailed views, technical descriptions, and parts lists.
- .8 Schematics and interconnection lists: Include schematic and wiring diagrams, interconnection lists, printed circuit board layouts with component identification, component parts lists with electronic substitutions, cross-referenced components lists, and sequences of operations.
- .9 Troubleshooting and fault location guide: Provide instructions to quickly return malfunctioning equipment to operation.
- .10 Routine servicing and preventative maintenance schedule: Include required tasks and estimated hours for servicing and preventative maintenance.
- .11 Complete set of reviewed shop drawings.
- .12 Product data: Clearly mark each sheet to identify specific Products and component parts. Delete inapplicable information.
- .13 Drawings: Supplement Product data to illustrate relationships between component parts, control diagrams, and flow diagrams as required.

- .14 Typed text: Provide additional instructions as required to supplement Product data. Include a logical sequence of instructions for each procedure, incorporating the manufacturer's instructions and those required by the Specifications.

3. **DRAWINGS**

- 3.1 Prepare all required drawings on CAD(.dwg format), using CAD Version 2019 or higher.
- 3.2 Ensure CAD drawings comply with the CAD Standards and Procedures provided by the Owner or Consultant.
- 3.3 Deliver one external hard drive containing all final drawings prepared under this Contract to the Consultant. Include, but do not limit to, circuit drawings, equipment layout drawings, and shop drawings.
- 3.4 Final drawings shall be sized at 560 mm x 860 mm. Provide half-size reproductions measuring 280 mm x 430 mm as well.
- 3.5 Before Contract Completion, provide the Consultant with one complete set of CAD Drawing Files in AutoCAD format, stored on media acceptable to the Consultant. Include all final drawings prepared under this Contract, such as circuit drawings, equipment layout drawings, and shop drawings.
- 3.6 Text files shall be prepared in a word processing program approved by the Owner.
- 3.7 Authorized deviations from drawings shall be marked in red accurately on one set of drawing prints in a neat, legibly printed manner and shall be dated. Prior to final inspection, neatly transfer the recorded information to a second set of drawing prints of the most recent revision to the drawings and submit both sets to the Consultant.
- 3.8 Maintain as-built drawings up to date as Work progresses. Status of maintained as-built drawings may be considered as a condition for validation of applications for payment.
- 3.9 Identify each as-built drawing as "As-Built Copy" and maintain the as-built drawings in good condition. Make as-built drawings available to the Consultant at all times.
- 3.10 As-built drawings shall include accurate dimensioned record of deviations and changes in Work from drawings.
- 3.11 As-built drawings shall be signed and dated by Contractor.
- 3.12 Submit as-built drawing to Consultant for review and make corrections as directed by Consultant.
- 3.13 Record accurately all deviations in the Work.
- 3.14 Accurately record locations of concealed structure, mechanical and electrical services and similar Work not clearly in view, the location of which is required for maintenance, alteration Work and future additions. Do not conceal such Work until the location has been recorded.
- 3.15 Accurately record locations of equipment bases, anchors, concrete pads and roof curbs, sleeves, piping, conduits, ducts, maintenance holes and valves, etc. located either below, outside or within structure.

- 3.16 Where piping, conduits and ducts are underground, underfloor, embedded in concrete or otherwise in inaccessible locations, accurately record with respect to structure column lines or walls and elevations with respect to finished floor levels or grades referenced to the centre line of components.
- 3.17 Integrate all changes and additional information marked on record prints.
- 3.18 Redraw and annotate changes where necessary. Clearly bubble revisions, note them in the revision column, and submit for Consultant review before Substantial Completion.
- 3.19 Accurately record any components which will be in inaccessible locations for Consultant's review before the component is covered, or buried, or made inaccessible.
- 3.20 CAD (Dwg) 2D drawings of Contract Drawings can be obtained from Consultant at a cost of \$750.00 plus HST per sheet drawing and with a signed CAD Wavier.
- 3.21 Clearly and prominently mark each drawing "AS-BUILT DRAWING prepared by _____ (name of Contractor)"

4. **TRANSMITTAL**

- 4.1 Forward storage media to the Owner through the Consultant, accompanied by a transmittal form. The transmittal form shall include a list of all file names contained on the storage media.
- 4.2 Data submitted to the Owner shall include the following files in addition to the design information:
 - .1 Library parts or cells utilized in the design files.
 - .2 Level conventions employed for each design file.
 - .3 Plotting instructions, including color tables, pen tables, and plot scale, used to prepare hard copies.
 - .4 Working units defined within the design files.
 - .5 Font library, if non-standard fonts were utilized in the design files.

5. **RECORDING ACTUAL SITE CONDITIONS**

- 5.1 Record information on a set of black-line opaque drawings and in the Project Record copy of the drawings and project manual.
- 5.2 Use felt-tip pens, assigning a distinct color for each major system to ensure clarity.
- 5.3 Record information as construction progresses. Do not conceal Work before recording all required data.
- 5.4 Legibly mark Contract Drawings and shop drawings to document:
 - .1 Measured depths of foundation elements relative to the finished first-floor datum.
 - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

- .3 Field changes to dimensions or details.
- .4 Modifications made by addenda or change orders.
- .5 Additional details not included in the original drawings.
- .6 References to related shop drawings and modifications.
- 5.5 Clearly annotate specifications to reflect actual construction, such as:
 - .1 Manufacturer, trade name, and catalog number of installed products, including optional or substituted items.
 - .2 Modifications introduced through addenda and change orders.
- 5.6 Retain manufacturer certifications, inspection certifications, and field test records as required by specification sections.
- 6. **FINAL SURVEY**
 - 6.1 Provide a final site survey certificate in compliance with Section 01 71 23, certifying that all elevations and locations meet the Contract Documents.
- 7. **MATERIALS AND FINISHES**
 - 7.1 Include details such as catalog numbers, sizes, composition, colors, and texture designations. Provide reordering information for custom-manufactured products.
 - 7.2 Provide guidance on cleaning agents, precautions, and schedules for cleaning and maintenance.
 - 7.3 Include the manufacturer's recommendations for cleaning and maintaining weather-exposed items.
 - 7.4 Comply with individual specification sections.
- 8. **SPARE PARTS**
 - 8.1 Provide spare parts in the quantities specified.
 - 8.2 Ensure items match the quality and manufacture of installed products.
 - 8.3 Deliver to the specified location, catalog items, and submit an inventory listing to the Consultant.
 - 8.4 Obtain receipts for delivered items and submit them before the Final Certificate of Measurement.
- 9. **MAINTENANCE MATERIALS**
 - 9.1 Provide maintenance and extra materials as specified.

9.2 Deliver items of the same quality and manufacture as installed products. Catalog and inventory items for submission to the Consultant.

9.3 Obtain and submit receipts before the Final Certificate of Measurement.

10. STORAGE, HANDLING, AND PROTECTION

10.1 Store spare parts, materials, and tools in a way that prevents damage or deterioration.

10.2 Store items in original packaging, with seals and labels intact. Weatherproof enclosures should be used where required.

10.3 Replace damaged items at no cost, ensuring Consultant satisfaction.

11. WARRANTIES AND BONDS

11.1 Separate each warranty or bond with index tabs matching the Table of Contents.

11.2 Include details such as subcontractor and manufacturer names, addresses, and phone numbers.

11.3 Obtain and submit warranties and bonds in duplicate, ensuring proper form and notarization where required.

11.4 Retain all warranties and bonds until the specified submission time.

12. PRE-WARRANTY CONFERENCE

12.1 Schedule a meeting with the Consultant before contract completion to understand warranty requirements.

12.2 Establish procedures for defect notifications, prioritization, and response times.

12.3 Provide the name, address, and phone number of an authorized company for warranty actions, ensuring responsiveness and availability within the local service area.

END OF SECTION

1. **ADMINISTRATIVE REQUIREMENTS**

- 1.1 Demonstrate the operation and maintenance of equipment and systems to the Owner's personnel before the date of Substantial Performance of the Contract.
- 1.2 Coordinate with the Owner to identify personnel for instructions and arrange their attendance at agreed times.

2. **PREPARATION**

- 2.1 Confirm conditions for demonstration and instructions meet requirements.
- 2.2 Ensure designated personnel are present.
- 2.3 Verify equipment has been inspected, started, and is operational per specifications and manufacturer recommendations.
- 2.4 Confirm testing, adjusting, and balancing have been completed as per SECTION 01 91 10 "Commissioning Cx," and all systems are fully functional.

3. **DEMONSTRATION AND INSTRUCTIONS**

- 3.1 Demonstrate start-up, operation, control, adjustment, troubleshooting, servicing, and maintenance of each equipment item at its location.
- 3.2 Instruct personnel on all phases of operation and maintenance, using operation and maintenance manuals as reference.
- 3.3 Review the manual contents thoroughly, explaining operation and maintenance aspects.
- 3.4 Add supplementary data to operation and maintenance manuals if necessary during instructions.
- 3.5 Time Allocated for Instructions:

- .1 Roof Anchors and Safety Restraints: 4 hour
- .2 Door Hardware: 4 hours
- .3 Domestic Water Heaters and Storage Tanks: 4 hours
- .4 Plumbing Fixtures: 4 hours
- .5 Variable Frequency Drives: 4 hours
- .6 Pumps - Hydronic Systems: 4 hours
- .7 Commercial Fans System: 4 hours
- .8 Packaged Boilers: 4 hours

- .9 Energy Recovery Ventilator: 4 hours
- .10 EMCS Training: Four 4-hour sessions
- .11 Solar PV Equipment: 4 hours
- .12 Power Generation Gas: 8 hours
- .13 Geothermal System: 8 hours
- 4. Action and Informational Submittals
 - 4.1 Submit in accordance with SECTION 01 33 00 "Submittal Procedures."
 - 4.2 Provide a schedule of demonstration dates and times for each equipment item and system at least two weeks in advance for Owner approval.
 - 4.3 Submit reports within one week after each demonstration, confirming satisfactory completion of demonstrations and instructions.
 - 4.4 Include the time, date, and attendees for each demonstration.
 - 4.5 Supply completed operation and maintenance manuals for use during demonstrations and instructions.
- 5. **QUALITY ASSURANCE**
 - 5.1 For Sections specifying manufacturer-provided demonstrations:
 - .1 Ensure the manufacturer's authorized representative instructs the Owner's personnel.
 - .2 Submit a written report verifying completion of demonstrations and instructions.

END OF SECTION

1. **RELATED DOCUMENTS**

- 1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, are applicable to this Section.
- 1.2 The OPR and BoD documentation prepared by the Owner and the Design Team includes requirements relevant to this Section.

2. **SUMMARY**

- 2.1 This Section specifies general requirements for commissioning without reference to specific systems, subsystems, and equipment.

3. **DEFINITIONS**

- 3.1 BoD: Basis of Design.
- 3.2 CxA: Commissioning Authority, responsible for planning, scheduling, and coordinating the commissioning team.
- 3.3 OPR: Owner's Project Requirements.
- 3.4 Systems, Subsystems, and Equipment: "As-built" systems, subsystems, and equipment.
- 3.5 TAB: Testing, Adjusting, and Balancing.
- 3.6 Design Team: Includes architects, engineering consultants, and others involved in the project design process.

4. **COMMISSIONING TEAM**

- 4.1 Individuals, each having authority to act on behalf of the entity they represent, explicitly organized to implement the commissioning process through coordinated actions.
- 4.2 The commissioning team shall include, but not be limited to, representatives of Mechanical and Electrical disciplines, various Specialty Contractors, Project Superintendent, subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
- 4.3 Members Appointed by the Owner
 - .1 CxA: The designated person, company, or entity responsible for planning, scheduling, and coordinating the commissioning team to implement the commissioning process. The Owner will engage the CxA under a separate contract.
 - .2 Representatives of the facility user and operation and maintenance personnel.
 - .3 Architect and Engineering design professionals.

5. **OWNER'S RESPONSIBILITIES**

- 5.1 Provide the OPR documentation to the CxA and the Contractor to assist in developing the commissioning plan, systems manual, operation and maintenance training plan, and testing plans and checklists.

- 5.2 Assign operation and maintenance personnel and schedule their participation in commissioning team activities, including:
 - .1 Coordination meetings.
 - .2 Training in operation and maintenance of systems, subsystems, and equipment.
 - .3 Testing meetings.
 - .4 Demonstration of operation of systems, subsystems, and equipment.
- 5.3 Provide utility services required for the commissioning process unless otherwise specified as the Contractor's responsibility.
- 5.4 Provide the BoD documents, prepared by the Design Team and approved by the Owner, to the CxA and Contractors participating in the commissioning process to facilitate development of the commissioning plan, systems manual, and operation and maintenance training plan.
- 6. **CONTRACTOR'S RESPONSIBILITIES**
 - 6.1 Provide utility services required for the commissioning process if not the responsibility of the Owner.
 - 6.2 The Contractor shall assign representatives with expertise and authority to act on behalf of the Contractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following
 - .1 Participate in construction-phase coordination meetings.
 - .2 Participate in maintenance orientation and inspection.
 - .3 Participate in operation and maintenance training sessions.
 - .4 Participate in final review at acceptance meeting.
 - .5 Certify that the Work is complete and systems are operational according to the Contract Documents, including calibration of instrumentation and controls.
 - .6 Evaluate performance deficiencies identified in test reports and, in collaboration with the entity responsible for system and equipment installation, recommend corrective action.
 - .7 Review and approve final commissioning documentation.
- 6.3 Subcontractors shall assign representatives with expertise and authority to act on behalf of Subcontractors and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
 - .1 Participate in construction-phase coordination meetings.
 - .2 Participate in maintenance orientation and inspection.
 - .3 Participate in procedures meetings for testing.

- .4 Participate in the final review at the acceptance meeting.
- .5 Provide schedules for operation and maintenance data submittals, equipment start-up, and testing to the CxA for incorporation into the commissioning plan. Update the schedule on a weekly basis throughout the construction period.
- .6 Provide information to the CxA for developing the construction-phase commissioning plan.
- .7 Participate in training sessions for the Owner's operation and maintenance personnel.
- .8 Provide updated Project Record Documents to the CxA on a daily basis.
- .9 Gather and submit operation and maintenance data for systems, subsystems, and equipment to the CxA, as specified in Section 01 78 23 Operation and Maintenance Manuals".
- .10 Provide technicians who are familiar with the construction and operation of installed systems and who shall develop specific test procedures and participate in testing of installed systems, subsystems, and equipment.

7. **CxA's RESPONSIBILITIES**

- 7.1 Coordinate the activities of the commissioning team, ensuring clear organization and direction throughout the process.
- 7.2 Develop a detailed plan for the construction phase, including test and inspection protocols, incorporating updates to designs, and scheduling commissioning tasks in alignment with the project timeline. Clearly outline responsibilities for team members, specifying names, organizations, and areas of expertise.
- 7.3 Review contractor and subcontractor submissions to verify alignment with the Owner's Project Requirements (OPR), Basis of Design (BoD), contract specifications, and the construction-phase commissioning plan. Provide detailed feedback on system performance and integration with other components.
- 7.4 Organize meetings with the commissioning team to ensure effective collaboration, address conflicts, and track progress. Coordinate logistics, prepare agendas and attendance records, and notify participants. Record and distribute meeting notes to all attendees within ten working days.
- 7.5 At the start of the construction phase, convene an initial meeting to outline commissioning activities, establish schedules for submissions, training sessions, testing, and final project milestones.
- 7.6 Conduct site inspections to monitor construction progress, identifying and documenting any deficiencies. Assess installations for compliance with the OPR, BoD, and contract specifications, ensuring systems and equipment are accessible for maintenance and repair.
- 7.7 Create specific procedures and checklists for system testing and inspection tasks.

- 7.8 Plan, oversee, and document all tests, inspections, and start-up operations for systems and equipment.
- 7.9 Collect and organize test data, inspection records, and relevant certificates into the commissioning documentation.
- 7.10 Certify the acceptance and operational start date for equipment, initiating warranty coverage periods.
- 7.11 Review project documentation to confirm accuracy and request corrections where necessary. Ensure compliance with closeout submittal requirements for project records.
- 7.12 Evaluate and provide comments on operation and maintenance documentation to ensure it meets project requirements and aligns with established design and operational goals.
- 7.13 Design and implement a training program for operational and maintenance personnel, supported by skilled instructors. Record training sessions for future reference.
- 7.14 Document construction progress, including concealed elements, through video recordings.
- 7.15 Generate comprehensive commissioning reports detailing outcomes and processes.
- 7.16 Compile final documentation, integrating all relevant commissioning reports and updated project records into a cohesive deliverable.
- 8. **COMMISSIONING DOCUMENTATION**
 - 8.1 The Commissioning Authority is responsible for preparing, organizing, and maintaining documentation related to the commissioning process, ensuring all information is systematically stored and accessible.
 - 8.2 An index must be created that specifies the location of all commissioning documents.
 - 8.3 The Owner's Project Requirements (OPR) must be documented by the Commissioning Authority based on the owner's input. This document outlines the project's functional needs, operational expectations, and includes goals, measurable criteria, schedules, budgets, and success benchmarks.
 - 8.4 The Basis of Design (BoD) is prepared by the Design Team, providing detailed explanations of design decisions, calculations, and product selections that address the OPR. It includes narrative descriptions and itemized specifics supporting the design approach.
 - 8.5 The commissioning plan, prepared by the Commissioning Authority, must define the schedule, resource allocation, and documentation requirements for the commissioning process. This includes:
 - .1 Delivery and review timelines for submittals, manuals, and reports, ensuring alignment with overall commissioning activities.
 - .2 Organization and structure of all commissioning documentation, specifying responsible parties.

- .3 Systems and equipment selected for commissioning.
 - .4 Testing procedures and schedules, identifying involved parties.
 - .5 Preconditions for subsequent tasks.
 - .6 Responsibilities of commissioning team members.
 - .7 Observations to be performed.
 - .8 Requirements for training, including necessary materials.
 - .9 Expected performance criteria for systems, equipment, and controls.
 - .10 Specific dates for commissioning tasks, coordinated with the overall project schedule.
 - .11 Installed systems, including updates and changes during construction.
 - .12 Continuous updates to project record documents.
 - .13 Prestart and startup checklists with verification and testing processes.
 - .14 Detailed testing procedures with data collection methods.
- 8.6 Custom test checklists must be developed for each system, subsystem, and equipment, including interlocks and operational modes. These checklists should provide space for recording results, comments, and tester signatures.
- 8.7 Certificates of Readiness must be signed by all relevant contractors and installers, certifying that systems and components are prepared for testing. These are to be accompanied by completed and verified test checklists.
- 8.8 The Commissioning Authority must compile test results, observations, and data into detailed reports, supplemented with relevant documentation such as photographs. Reports should be included in both the commissioning report and the systems manual.
- 8.9 For systems or equipment that fail tests, corrective action documentation must detail the required modifications and provide retesting outcomes.
- 8.10 An issues log must track discrepancies from the OPR, BoD, or Contract Documents. Each entry should include a unique identifier, a description of the issue, recommended corrective actions, and a record of resolution.
- 8.11 A commissioning report must consolidate all findings, including test results, unresolved issues, and evaluations of performance relative to the OPR and BoD. It should include:
- .1 Explanations of substitutions, compromises, and variances from the OPR, BoD, and Contract Documents.
 - .2 A record of all conditions, with recommendations for resolution where necessary.
 - .3 OPR and BoD documentation.

- .4 Final commissioning plan.
 - .5 Testing plans and results.
 - .6 Corrective action documentation.
 - .7 Issues log and resolutions.
 - .8 Completed test checklists.
 - .9 Details of off-season testing not completed, with scheduled completion dates.
- 8.12 The systems manual must compile all necessary information for the operation and maintenance of the facility. It includes:
- .1 OPR and BoD documents with updated system narratives and schematics.
 - .2 Project record documents as required by SECTION 01 78 23.
 - .3 Final commissioning plan and report.
 - .4 Comprehensive operation and maintenance data.
9. **SUBMITTALS**
- 9.1 The CxA shall be responsible for submitting all required documentation to ensure the commissioning process is thoroughly documented.
- 9.2 The Commissioning Plan Pre-final Submittal must include six hard copies of the pre-final commissioning plan. One copy shall be delivered to the Contractor, one to the Owner, one to the Architect, and one to the Engineer. The submittal must provide sufficient detail to evaluate the data collection and arrangement process. One copy, with review comments, shall be returned to the CxA for preparation of the final construction-phase commissioning plan.
- 9.3 The Commissioning Plan Final Submittal shall consist of three hard copies and three sets of electronically formatted files of the final commissioning plan. One hard copy and one set of electronic files shall be delivered to the Owner, the Architect, and the Engineer. The final submittal must address all comments from the pre-final submittal and shall include a copy of the pre-final submittal review comments along with responses to each item.
- 9.4 Test Checklists and Report Forms must include sample checklists and forms provided by the CxA to the Contractor, the quality-control manager, and Subcontractors for review and comment. Two master copies of each checklist and report form shall be submitted.
- 9.5 Certificates of Readiness must be submitted by the CxA to confirm that systems, subsystems, and equipment are prepared for testing. These certificates must be accompanied by completed and signed checklists.
- 9.6 Test and Inspection Reports shall document all test data, observations, and measurements. These reports must be supplemented with photographs, forms, and any additional relevant documentation.

- 9.7 Corrective Action Documents must be submitted by the CxA to outline modifications required for systems or equipment that do not meet performance standards during testing. These documents shall include retesting plans and outcomes.
- 9.8 The Pre-final Commissioning Report Submittal must include three hard copies of the pre-final commissioning report. One copy shall be delivered to the Owner, one to the Architect, and one to the Engineer. The submittal must include the preliminary submittal review comments and responses. One copy, with additional comments, shall be returned to the CxA for preparation of the final submittal.
- 9.9 The Final Commissioning Report Submittal shall include three hard copies and three sets of electronically formatted files. One hard copy and one electronic set shall be delivered to the Owner, the Architect, and the Engineer. The final submittal must address all review comments from the pre-final report and include a copy of the reviewed pre-final submittal along with responses to each item.

10. **QUALITY ASSURANCE**

- 10.1 Instructor Qualifications: Factory-authorized service representatives experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.
- 10.2 Test Equipment Calibration: Comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments. Instruments shall have been calibrated within six months prior to use.

11. **COORDINATION**

- 11.1 Coordinating Meetings: The CxA shall conduct biweekly coordination meetings of the commissioning team to review progress on the commissioning plan, to discuss scheduling conflicts, and to discuss upcoming commissioning process activities.
- 11.2 Pretesting Meetings: The CxA shall conduct pretest meetings of the commissioning team to review start-up reports, pretest inspection results, testing procedures, testing personnel and instrumentation requirements, and manufacturers' authorized service representative services for each system, subsystem, equipment, and component to be tested.
- 11.3 Testing Coordination: The CxA shall coordinate the sequence of testing activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid the necessity of removing and replacing construction to accommodate testing and inspecting.

- .1 Schedule times for tests, inspections, obtaining samples, and similar activities.

- 11.4 Manufacturers' Field Services: The CxA shall coordinate the provision of manufacturers' field services.

12. **OPERATION AND MAINTENANCE TRAINING REQUIREMENTS**

- 12.1 Training Preparation Conference: Prior to conducting operation and maintenance training, the CxA will organize a preparation conference with the Owner's operation and maintenance staff, the Contractor, and Subcontractors participating in the Commissioning Process. In addition to meeting the requirements outlined in Section 01 79 00 "Demonstration and Training," the following tasks will be completed:

- .1 Review the OPR and BoD to ensure alignment with training objectives.
 - .2 Verify the installation of all relevant systems, subsystems, and equipment.
 - .3 Assess the qualifications of training instructors.
 - .4 Evaluate instructional methods and the planned procedures for training delivery.
 - .5 Examine the outlines and content of training modules for completeness.
 - .6 Review all course materials, including operation and maintenance manuals.
 - .7 Inspect and confirm the readiness of locations and facilities to be used for training sessions.
 - .8 Confirm the training schedule and ensure the availability of all necessary educational resources, instructors, audiovisual tools, and facilities to prevent delays.
 - .9 For outdoor training sessions, evaluate weather conditions and establish contingency procedures to manage unfavorable conditions.
- 12.2 Training Modules: Develop a structured training program comprising individual modules that address the operation and maintenance of each system, subsystem, and piece of equipment as specified in SECTION 01 79 00 "Demonstration and Training."

END OF SECTION

1 General

1.1 SECTION INCLUDES

- .1 Labour, Products, equipment and services necessary for demolition and removals Work in accordance with the Contract Documents.
- .2 Work included: Requirements for demolishing, salvaging and removing wholly or in part the various items designated on the drawings or required to be removed or partially removed for the receipt of the Work of this Contract, including not necessarily limited to:
 - .1 Alteration and renovations to existing building.
 - .2 Cutting and removing of walls, floors, ceilings, doors and frames, in the existing buildings as indicated on Drawings.
 - .3 Patching, making good openings and chases in walls, floors, ceilings, including the supply and installation of lintels, channels and finishes.
 - .4 Removal of rubbish, debris, demolished fixtures, fittings and items not scheduled to remain the Owner's property, resulting from the demolition and preparatory work.
 - .5 Remove abandoned services such as conduits, pipes, wiring, ducts, fixtures, equipment, etc. where required for the work or indicated on the drawings.
 - .6 Removal of all mechanical items including plumbing fixtures, services etc. where required for the work or indicated on drawings and or where not required to be relocated.
 - .7 Removal of existing electrical items including fixtures, etc. where required for the work or indicated on the drawings and not required to be relocated.
 - .8 Dust control during the operations of the work of this Section.
 - .9 Removal shall mean removal from site and safe disposal in a legal manner

1.2 REFERENCES

- .1 CSA S350-M, Code of Practice for Safety in Demolition of Structures.
- .2 OPSS, Ontario Provincial Standard Specification.

1.3 SUBMITTALS

- .1 Where required by Authorities having jurisdiction, submit a Fire Plan to local fire department for review and approval.
- .2 Submit shop drawings, diagrams and details in accordance with Section 01 33 00.
- .3 30 calendar days prior to start of demolition and removals work, submit for review, drawings, diagrams or details showing sequence of disassembly work and shoring of supporting structures in accordance with authorities having jurisdiction.
- .4 Submit for approval, a plan showing impacts, interruptions and delays to Owners operations
- .5 Submit Dust Control Plan conforming to requirements of the City of Toronto's Public Health Services.

- .6 Have submissions signed and sealed by Professional Engineer licensed in Province of Ontario.
- .7 Submit to Consultant, details of where rubble, debris and other materials are to be disposed or reused. Include each disposal/reuse site location, operator's name and business address, type of license under which site operates, and criteria used by site to assess suitability of rubble, debris and other materials for disposal.
- .8 Give notice to Utility Authorities controlling services and appurtenances which will be affected by demolition work.

1.4 **QUALITY ASSURANCE**

- .1 Prepare waste audits, waste reduction workplans, source separation programs and recycling programs as required by jurisdictional authorities and update programs and implement such programs as required.
- .2 Perform the work of this section in accordance with the 'Environmental Protection Act' including Ontario Regulation 102 and the 'Environmental Assessment Act' including Ontario Regulation 103.
- .3 Conform to Fire Code, Regulation under the Fire Marshals Act.
- .4 The demolition contractor must engage a registered professional engineer who holds a certificate of authorization and an appropriate level of liability insurance to prepare demolition procedures.
- .5 As part of the contract requirements, the engineer for the demolition contractor should be required to sign the general review commitment required by city building departments.

1.5 **SITE CONDITIONS**

- .1 Interruptions to Owners operations will not be permitted.
- .2 Perform operations, machine and equipment movements, deliveries and removals at time or times that will permit uninterrupted operations in and around structures, including parking, deliveries, and Site access and egress.
- .3 Take over structures to be demolished based on condition on date that Tenders close.
- .4 Contractor shall photo document all existing conditions prior to demolition and make such material available to Consultant.

2 Products

2.1 **MATERIALS**

- .1 All materials requiring removal shall become the Contractor's property and shall be removed and disposed of from the site, as the work progresses, unless indicated otherwise.
- .2 Salvaged material:
 - .1 Salvage and stockpile Products, materials, and equipment as specified herein, indicated on Site or indicated on drawings.
 - .2 Coordinate items to be salvaged with Owner. Dispose of items Owner deems to be of no further use.

- .3 Salvaged materials shall not be chipped, cracked, split, stained or damaged.
- .4 Store items off of moist surfaces.

3 Execution

3.1 GENERAL

- .1 Clean up rubble and debris, resulting from work promptly and dispose at end of day or place in waste disposal bins. Empty bins on regular basis.
- .2 Stockpiling of rubble, debris, and surplus Products on Site will not be permitted.
- .3 Remove, handle and transport Products indicated to be salvaged and stored for future use. Transport Products to storage area(s) designated by Consultant. Perform work to prevent any damage to Products during removal and in storage. Products damaged during removal, will be inspected by Consultant. Consultant will determine extent of damage and accept or refuse Products.
- .4 List and description of items to be removed and stored or reused:
 - .1 Items as indicated on the drawings or by the Consultant.
- .5 Tag and log all items to be salvaged to the satisfaction of the Consultant. Ensure identification tags do not damage items to be salvaged and are non-permanent, removable and durable.
- .6 Communicate Dust Control Plan procedures to all appropriate personnel on site and their head offices and due diligence measures to be maintained to control all fugitive emissions.
- .7 Take precautions to guard against movement, settlement or collapse of adjacent services, sidewalks, driveways, or trees. Be liable for such movement, settlement or collapse caused by failure to take necessary precautions. Repair promptly such damage when ordered.

3.2 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Examine adjacent structures and other installations prior to commencement of demolition and removals work.

3.3 PRESERVATION OF REFERENCES

- .1 Record location and designation of survey markers and monuments located within demolition area, prior to removal. Store and restore markers and monuments upon completion of Work or relocate as directed by Consultant.

3.4 PROTECTION

- .1 Prevent movement or damage of adjacent structures, services, walks, paving, trees, landscaping, adjacent grades, and parts of existing structure to remain. Supply and install bracing and shoring as required. Make good damage caused by demolition to acceptance of Consultant.

- .2 Protect adjacent structures and property against damage which might occur from falling debris or other causes. Repair or replace damage caused from work of this Section to acceptance of Consultant.
- .3 Do not interfere with use of adjacent structures and Work areas. Maintain free, safe passage to and from adjacent structures and Work areas.
- .4 Take precautions to support affected structures. If safety of structure being demolished, adjacent structures or services are endangered, cease demolition operations and take necessary action to support endangered item. Immediately inform Consultant. Do not resume demolition until reasons for endangering have been determined and corrected and action taken to prevent further endangering.
- .5 If movement or settlement occurs, install additional bracing and shoring as necessary and make good damage to acceptance of Consultant.
- .6 Hang tarpaulins where debris and other materials are lowered. Build in around openings with wood and plywood at locations used for removal of debris and materials.
- .7 Prevent debris from blocking surface drainage system, elevators, mechanical, and electrical systems which are required to remain in operation.
- .8 Pay particular attention to prevention of fire and elimination of fire hazards which would endanger Work or adjacent structures and premises.
- .9 Supply and install adequate protection for materials to be re-used, set on ground and prevent moisture pick-up. Cover stockpiles of materials with tarpaulins.
- .10 Close off access to areas where demolition is proceeding by barricades and post warning signs.
- .11 Supply, install and maintain legal and necessary barricades, guards, railings, lights, warning signs, security personnel and other safety measures, and fully protect persons and property.
- .12 Dust/weather partitions:
 - .1 Prior to demolition work proceeding in existing structures, temporarily enclose Work areas, access and supply and install dustproof and weatherproof partitions. Design partitions to prevent dust and dirt infiltration into adjoining areas, prevent ingress of water, and to resist loads due to wind.
 - .2 Prevent dust, dirt and water from demolition operations entering operational areas.
 - .3 Adjust and relocate partitions as required for various operations of work.
 - .4 Upon completion of work, remove and dispose of partitions from Site.
- .13 Dust protection:
 - .1 Perform dust control procedures in accordance with approved Dust Control Plan and work of this Section.
 - .2 Clean water to be applied to hard and soft surfaces and on open excavation faces on Site daily to eliminate dust.
 - .3 Roadways and sidewalks to be cleaned daily or as required.

- .4 A designated truck loading area on granular material or existing asphalt to be used to mitigate tracking of potentially contaminated soil and demolition debris off Site. Contaminated loading points to be cleaned or re-established.
 - .14 Removed skylights:
 - .1 Provide temporary protective sheeting over removed skylights.
 - .2 Turn sheeting up and over parapets and curbing. Retain sheeting in position with weights or temporary fasteners.
 - .3 Provide for surface drainage from sheeting to roof drains.
 - .4 Do not permit traffic over unprotected or repaired deck surface.
 - .15 Blasting is not permitted
- 3.5 **PREPARATION**
- .1 Disconnect and/or re-route electrical data, communication and telephone service lines entering structures to be demolished. Remove abandoned lines as indicated on Contract Drawings. Post warning signs on electrical lines and equipment which is required to remain energized.
 - .2 Disconnect and cap designated mechanical services:
 - .1 Natural gas supply lines: As indicated on drawings, to be removed by qualified workers in accordance with gas company instructions.
 - .2 Sewer and water lines: Remove and dispose of as indicated on Contract Drawings.
 - .3 Other underground services: Remove and dispose of as indicated on Contract Drawings.
 - .3 Disassemble and remove mechanical equipment, ductwork and piping complete with supports and associated components.
 - .4 Do not disrupt active or energized utilities designated to remain undisturbed
 - .5 Perform rodent and vermin control to comply with health regulations
- 3.6 **DEMOLITION**
- .1 Perform demolition with extreme care. Confine effects of demolition to those parts which are to be demolished.
 - .2 Perform work and prevent inconvenience to persons outside those parts which are to be demolished.
 - .3 Carry out demolition in accordance with the requirements of CSA S350-M.
 - .4 Demolish parts of structure to permit remedial work as indicated
 - .5 Demolition shall proceed safely in systematic manner from roof to grade and as necessary to accommodate remedial work indicated. Work on each floor level shall be complete before commencing work on supporting structure and safety of its supports are impaired. Parts of building which would otherwise collapse prematurely shall be securely shored. Walls and piers shall not be undermined.
 - .6 Do not overload floor or wall with accumulations of material or debris or by other loads.

- .7 Perform work to minimize dusting. Keep work area wetted down with fog sprays to prevent dust and dirt rising. Supply and install temporary water lines and connections that may be required. Upon completion, remove installed temporary water lines. Use covered chutes, water down.
- .8 Do not sell or burn materials on Site.
- .9 Remove existing equipment, services, and obstacles where required for refinishing or making good of existing surfaces, and replace as Work progresses.
- .10 At end of day's work, leave Work in safe condition with no part in danger of toppling or falling. Protect interiors of parts not to be demolished from exterior elements.
- .11 Drainage and sewer system protection:
 - .1 Ensure that no dust, debris or slurry enters drainage and sewer system on Site.
 - .2 Remove and dispose of debris and slurry promptly from Site.
 - .3 Comply with City of Toronto Sewer Use By-Law.
- .12 Concrete:
 - .1 Perform concrete demolition using methods that minimize impact loads on elements that are to remain intact.
 - .2 When partial demolition of a concrete floor, wall, or similar structure is required, isolate areas to be removed using saw cuts unless reinforcing steel is to remain in place. Before isolation, install suitable supports to prevent premature movement and unintended load transfers during cutting. Remove sections incrementally if necessary to ensure stability.
 - .3 When retaining reinforcing steel, use saw cuts around the perimeter of the demolition area to a depth sufficient to expose the steel. Chip away concrete carefully to avoid damaging the steel. Repair any damage to epoxy coatings on the existing reinforcing steel.
- .13 Steel: Dismantle structural steel elements in a manner that maintains the overall stability of the structure when only part of the steel is to be removed. Avoid placing excessive loads on components. Install adequate temporary bracing and supports to ensure stability. Support and lower disconnected components carefully; do not drop them.
- .14 Create openings in existing walls, partitions, and floors, ensuring that the exact locations of steel reinforcement in concrete slabs or walls are identified before cutting. Avoid damage to steel reinforcement; any resulting structural failure is the responsibility of the contractor. Restore disturbed surfaces with materials that match the existing finish.
- .15 Cut openings through existing walls, partitions, roofs and floors. Establish exact location of steel reinforcing in existing concrete slabs or walls before cutting. Be responsible for damage to existing steel reinforcing and be liable for structural failure. Make good surfaces disturbed with materials to match existing.

- .16 Where doors are scheduled to be removed, include:
 - .1 Removal in re-usable condition of door hardware.
 - .2 Removal of doors and door frames.
- .17 Remove interior partitions, fittings, fixtures and accessories as indicated on drawings. Partitions and walls shall be removed full height to structure above.
- .18 Remove interior finishes, such as ceiling and floor finishes, where new finishes are indicated on Room Finish Schedule.
 - .1 Removal of existing ceilings shall include complete removal including bulkheads and suspension system.
 - .2 Removal of adhesive applied finishes shall include complete removal to substrate including adhesive. Take adequate care to prevent damage to substrate.
- .19 Remove existing floor finishes, include mortar bed, underlayment or other cleavage membranes, base, floor moulding and transition strips.
- .20 Demolish all other items indicated or required.

3.7 **DISPOSAL OF MATERIALS**

- .1 Remove from Site, rubble, debris, and other materials resulting from demolition and removals work in accordance with Authorities having Jurisdiction, except where specified or indicated on Contract Drawings to be reused.
- .2 Conform to requirements of municipality's Works Department regarding disposal of waste materials.
- .3 Materials prohibited from municipality waste management facilities shall be removed from Site and dispose of at recycling companies specializing in recyclable materials.

3.8 **RESTORATION**

- .1 Where demolition removed a structure or installation, rough grade and restore area in accordance with Authorities having Jurisdiction.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section includes descriptions for demolishing, salvaging, recycling and removing site work items identified for removal in whole or in part, and for backfilling trenches and excavations resulting from site demolition activities.
- .2 Project specific requirements are to be as indicated on the drawings and in other Sections of the Specifications.

1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination: Coordinate with Owner for the material ownership including the following:
 - .1 Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor 's property and shall be removed from Project site.
 - .2 Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered during demolition remain Owner's property:
 - .1 Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to Owner.
 - .2 Coordinate with Owner, who will establish special procedures for removal and salvage operations.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Action Submittals: Provide the following submittals before starting any work of this Section:
 - .1 Shop Drawings: not required.
 - .2 Schedule of Site Demolition Activities (incorporate into project schedule as may be applicable)
 - .1 Detailed sequence of site demolition and removal work, with starting and ending dates for each activity
 - .2 Interruption of utility services
 - .3 Coordination for shutoff, capping, and continuation of utility services
 - .4 Locations of temporary hoarding and means of egress
 - .3 Proposed Noise and Dust Control Measures: Submit statement or drawing that indicates measures proposed for use, proposed locations, and proposed time frame for their operation.
 - .4 Inventory: Submit a list of items that have been removed and salvaged after site demolition is complete
 - .5 Pre demolition Photographs: Submit photographs indicating existing conditions of adjoining areas prior to starting Work. Include finish surfaces that may be misconstrued as damage caused by site demolition operations.
 - .6 Disposal Records: indicate receipt and acceptance of materials designated to be recycled or materials required by law to be disposed at licensed facilities.

1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: ensure Work is performed in compliance with Province of Ontario Regulations and City of Toronto Bylaws.
- .2 Comply with hauling and disposal regulations of all Authorities Having Jurisdiction.

1.5 SITE CONDITIONS

- .1 Environmental protection:
 - .1 Ensure Work does not adversely affect adjacent watercourses, groundwater and wildlife, or contribute to excess air and noise pollution.
 - .2 Fires and burning of waste or materials is not permitted on site.
 - .3 Burying of rubbish waste materials is not permitted.
 - .4 Disposal of waste of volatile materials including but not limited to, mineral spirits, oil, petroleum based lubricants, or toxic cleaning solutions into watercourses, storm or sanitary sewers, is not permitted.
 - .5 Ensure proper disposal procedures are maintained throughout the project.
- .2 Pumping of water containing suspended materials into watercourses, storm or sanitary sewers or onto adjacent properties, is not permitted.
- .3 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with authorities having jurisdiction.
- .4 Protect trees, plants and foliage on site and adjacent properties where indicated.
- .5 Prevent extraneous materials from contaminating air beyond application area, by providing temporary enclosures during demolition work.
- .6 Cover or wet down dry materials and waste to prevent blowing dust and debris. Control dust on all temporary roads.
- .7 Maintain access to existing walkways, and other adjacent facilities:
- .8 Closing or obstructing walkways, or other facilities without written permission from Owner or Consultant is not permitted.
- .9 Owner and Consultant assume no responsibility for elements being demolished:

1.6 EXISTING CONDITIONS

- .1 Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work:
- .2 If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Owner and Consultant. Hazardous materials may be removed by Owner under a separate contract or as a change to the Work.
- .3 If material resembling spray or trowel applied asbestos or other designated substance is encountered in course of demolition, stop work, take preventative measures, and notify Owner and Consultant immediately. Proceed only after receipt of written instructions have been received from Owner or Consultant.
- .4 Site elements that will be demolished are based on their condition on date that tender is accepted.

PART - 2 PRODUCTS

2.1 NOT USED

- .1 Not used.

PART - 3 EXECUTION

3.1 EXAMINATION

- .1 Survey existing conditions and correlate with requirements indicated to determine extent of site demolition required.
- .2 Consultant and Owner do does not guarantee that existing conditions are the same as those indicated in Project Record Documents.
- .3 Inventory and record the condition of items being removed and salvaged.
- .4 When unanticipated mechanical, electrical, or structural elements are encountered; investigate and measure the nature and extent of the element. Promptly submit a written report to Owner and Consultant.
- .5 Where applicable, perform an engineering survey of condition of adjacent structures to determine whether removing any site element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during site demolition operations.
- .6 Verify that hazardous materials have been remediated before proceeding with site demolition operations.

3.2 PREPARATION

- .1 Temporary Erosion and Sedimentation Control:
 - .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
 - .2 Inspect, repair, and maintain erosion and sedimentation control measures during demolition.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal after completion of demolition work.
- .2 Protection of in-place conditions:
 - .1 Prevent movement, settlement or damage of adjacent structures, services, walkways, paving, trees, landscaping, properties.
 - .1 Provide bracing, shoring and underpinning as required.
 - .2 Repair damage caused by demolition as directed by Owner or Consultant.
 - .2 Support affected site elements and, if safety of site element being demolished, or of services or adjacent structures appears to be endangered, take preventative measures, stop Work and immediately notify Owner and Consultant.
 - .3 Prevent debris from blocking surface drainage system, or mechanical and electrical systems which must remain in operation.
- .3 Surface Preparation:
 - .1 Disconnect and if applicable, re-route electrical and service lines within the site to be demolished.
 - .1 Post warning signs on electrical lines and equipment which must remain energized to serve other properties during period of site demolition.
 - .2 Disconnect and cap designated services.
 - .1 Remove and dispose of or abandon in-place as indicated on the drawings.
- .4 Disruption of active or energized utilities designated to remain undisturbed is not permitted.

3.3 REMOVAL AND DEMOLITION OPERATIONS

- .1 Remove items as indicated.

- .2 Disruption of items designated to remain in place is not permitted.
- .3 Removal of pavements, curbs and gutters:
 - .1 Square up adjacent surfaces to remain in place by saw cutting or other method indicated by Consultant or Owner.
 - .2 Protect adjacent joints and load transfer devices.
 - .3 Protect underlying and adjacent granular materials if indicated to be retained.
- .4 Excavate at least 300 mm below pipe invert, when removing pipes under existing or future pavement area.
- .5 Decommission water wells and monitoring wells in accordance with regulations.
- .6 Remove only designated trees during demolition.
- .7 Stockpile topsoil for final grading and landscaping if indicated:
 - .1 Provide erosion control if not immediately used.
- .8 Salvage:
 - .1 Items to be salvaged: n/a
 - .2 Dismantle items containing materials for salvage and stockpile salvaged materials at locations as agreed by Owner.
- .9 Disposal of Material:
 - .1 Dispose of materials not designated for recycling, salvage or reuse legally off-site.
- .10 Backfill: Backfill in areas as indicated and in accordance with Section 31 23 33.01-Excavating, Trenching and Backfilling.

3.4 STOCKPILING

- .1 Designate appropriate security resources/measures to prevent vandalism, damage and theft.
- .2 Locate stockpiled materials convenient for use in new construction to eliminate double handling wherever possible.

3.5 RESTORATION

- .1 Restore areas and existing works outside areas of demolition to match condition of adjacent, undisturbed areas or conditions that existed prior to beginning of Work, as indicated.

3.6 CLEANING

- .1 Progress Cleaning:
 - .1 Leave Work area clean at end of each day.
 - .2 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.
 - .3 Remove debris, trim surfaces and leave work site clean, upon completion of Work
 - .4 Use cleaning solutions and procedures which are not harmful to health, are not injurious to plants, and do not endanger wildlife, adjacent water courses or ground water.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with General and Supplementary Conditions.

END OF SECTION 02 41 13

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Related Work Specified Elsewhere:
 - .1 Concrete Reinforcement, Section 03 20 00.
 - .2 Cast-in-Place Concrete, Section 03 30 00.
 - .3 Concrete Floor Finishes, Section 03 35 00.
- .2 Work Installed but Furnished Elsewhere:
 - .1 Structural Steel anchor assemblies, bolts and the like supplied under Section 05 12 00.

1.2 STANDARDS, CODES AND ACTS

- .1 Conform with the Ontario Building Code 2012 under Ontario Regulation 332/12, including Ontario Regulation 88/19, and any applicable acts of any authority having jurisdiction and the following (most recent edition, including any applicable supplements):
 - .1 CAN/CSA-A23.1 - Concrete Materials and Methods of Concrete Construction, Canadian Standards Association
 - .2 CAN/CSA-S269.1 - Falsework for Construction Purposes, Canadian Standards Association
 - .3 ACI-347R - Guide to Formwork for Concrete, American Concrete Institute.
 - .4 CAN/CSA-S269.3 - Concrete Formwork, Canadian Standards Association
 - .5 CAN/CSA-O86 - Engineering Design in Wood (Limit States Design), Canadian Standards Association.
 - .6 CAN/CSA-O121 - Douglas Fir Plywood, Canadian Standards Association.
 - .7 CSA STANDARD O151, Canadian Softwood Plywood.
 - .8 CAN/CSA O153, Poplar Plywood.
 - .9 CAN/CSA 3-O188.0, Standard Test Methods for Mat-Formed Wood Particleboards and Waferboard.
 - .10 CSA STANDARD O437.0, Standards for OSB and Waferboard.
 - .11 COFI Exterior Plywood for Concrete Formwork

- .2 Where there are differences between the specifications, drawings, codes, standards or acts, the most stringent shall govern.

1.3 TOLERANCES

- .1 Perform forming operations and place hardware so that finished concrete will be within the tolerances set out in CAN/CSA-A23.1.
- .2 These tolerances are acceptable with regard to visual and structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

1.4 DESIGN OF FORMS AND RESHORING

- .1 Design forms to safely support lateral loads until they can be supported by the structure. Design formwork for loads and lateral pressures recommended in ACI 347R/CAN/CSA-S269.3. Wood design to conform to CAN/CSA-O86.
- .2 Where required by the local authorities, arrange with the local building by-law authorities for approval of forms and shop drawings.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 00 Waste Management and Disposal and the Waste Reduction Workplan.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.
- .4 Use sealers, form release and stripping agents that are non-toxic, biodegradable and have zero or low VOC's.

PART 2 – PRODUCTS

2.1 MATERIALS

- .1 Forms
 - .1 Formwork lumber: plywood and wood formwork materials to CAN/CSA-A23.1
 - .2 Falsework materials: to CSA Standard S269.1, Table 1, bearing grade marks or accompanied with certificates, test reports or other proof of conformity.
 - .3 Sheathings for exposed surfaces: New, Douglas Fir Plywood not less than 18 mm thick, concrete form grade, solid one side, conforming to CSA Standard O121.
- .2 Expansion Joint Filler:
 - .1 Non-extruding resilient bituminous preformed expansion joint filler conforming to MTO Form 1308 Type A.
 - .2 Non-extruding resilient non-bituminous preformed expansion joint filler conforming to MTO Form 1308 Type B.

- .3 Rigid insulation for protection of foundations from frost adjacent to foundation walls and under normal paving slabs: Extruded Polystyrene, Styrofoam SM or equivalent.
- .4 Rigid insulation for protection of foundations from frost under footings and rafts and heavy use normal paving slabs: Extruded Polystyrene, Styrofoam Highload 100 or equivalent.
- .5 Form release agent: non-toxic, biodegradable, low VOC product such as Clean Strip WB (J-4) distributed by Dayton Superior, Clean Strip Ultra (J-3 V.O.C.), Euro Wax or approved equivalent.

PART 3 – EXECUTION

3.1 FORMS

- .1 General
 - .1 Design, erect, support, brace and maintain formwork to safely support vertical and lateral loads until they can be supported by the structure.
- .2 Construction
 - .1 Form footing sides unless footings are shown to be placed against undisturbed soil.
 - .2 Build top forms on sloping concrete where required to prevent flow of the concrete out of the forms. Provide vents to top forms to permit air or bleed water to escape from the forms.
 - .3 Where concrete is poured against structural steel beams causing unbalanced horizontal pressures, provide sufficient horizontal support to resist such pressures and to prevent deflection of the steel beams.
 - .4 Mark building, grid or other lines on forms as required to permit the accurate positioning of reinforcing steel.
 - .5 Construct templates and supports as required to rigidly fix reinforcing dowels in the forms prior to concreting.
 - .6 Where necessary, provide suitable markers to indicate the location and configuration of continuing concrete members so that dowels can be positioned accurately in relation to their position in the continuing members.
 - .7 Set anchor bolts, templates, steel connection units or other inserts into the forms and secure them rigidly so that they do not become displaced during concreting. Set and secure these items to the tolerances specified and required in the appropriate Sections.
- .3 Sleeves, Chases and Formed Openings
 - .1 All openings, sleeves, recesses are not necessarily shown on the structural drawings nor are their sizes or locations shown. Refer to architectural, mechanical and electrical drawings for openings and sleeving requirements not shown, located and dimensioned on the structural drawings.
 - .2 No sleeves, chases and openings through structural members shall be formed without the Consultant's approval.
 - .3 Where pipes or services pass through walls, beams or slabs, form the openings by an approved sleeve or form as necessary, except where such openings are specified to be formed or sleeved by the appropriate trade. Form chases or recesses as shown or required.

3.2 STRIPPING OF FORMS AND RESHORING

- .1 Where forms are stripped from horizontal or sloping members before concrete has reached its specified 28 day strength, reshore the members so that they can safely support their own load plus construction loads. In addition, ensure that the stripped member is of sufficient strength to safely carry its own weight over the area stripped out at any instant, together with any superimposed construction loads.
- .2 As a minimum, conform to requirements of CSA Standard S269.1 and the following:
 - .1 Side forms for vertical members may be stripped as soon as the concrete is sufficiently strong to stand unsupported and safely resist imposed loads.

3.3 CONSTRUCTION JOINTS

- .1 Obtain approval from the Consultant for location and details of construction joints not shown.
- .2 Provide reglets in joints as shown.

3.4 EXPANSION AND CONTROL JOINTS

- .1 Construct expansion and control joints at the locations indicated and in accordance with the details shown.
- .2 Construct clean expansion joints free of foreign material likely to impair the proper operation of the joint.
- .3 Provide a non-extruding joint filler in expansion joints for the full area between adjacent concrete members. Anchor the filler material to one of the adjacent members or between concrete members and adjacent members of other materials.
- .4 Where shown, provide waterstops in expansion joints. Make waterstops continuous for the full length of the joint and splice where necessary, in accordance with the manufacturer's instructions so that the waterstopping action will not be interrupted. Rigidly fix waterstops in forms to prevent their displacement during concreting.
- .5 Where waterstops are noted to be installed into existing work, sawcut appropriate sized slots into the new work and grout waterstops into the slots. Make waterstops continuous for the full length of the joint. Splice waterstops so that the waterstopping action will not be interrupted.
- .6 Expansion joints in walks shall be placed vertically at intervals at intervals of 6 m or as indicated on the drawings prior to placing concrete.
- .7 Divide sections between expansion joints in walks transversely into lengths not more than 1.5 m. Provide a radiused edge on all finish edges and divisions with a standard edger or groover, respectively.
- .8 Provide expansion joints in curbs transversely at intervals of 6 m 20', unless ordered otherwise by the Consultant. Such joints shall be asphalt impregnated felt, 12 mm, set perpendicularly to the surface of the curb and gutter and firmly secured to act as a bulkhead. Place the top of the felt 12 mm thick below the surface. Place removable cap pieces securely in position and remove when the concrete has achieved its initial set. Fill the groove thus formed after being thoroughly cleaned, with a bituminous filler material.

END OF SECTION 03 10 00

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Provide all material and labour required for the completion of the Contract. Breakdown of Work by Section is for guidance only and is not necessarily complete.
- .2 Work Furnished and Installed:
 - .1 Concrete reinforcement.
 - .2 Reinforcing bars for masonry.
- .3 Work Furnished but not Installed:
 - .1 Reinforcing bars for masonry, including lintels, band courses, and piers.
- .4 Work Installed but Furnished By Other Sections:
 - .1 Anchor bolts.
- .5 Related Work Specified Elsewhere:
 - .1 Concrete Formwork and Falsework, Section 03 10 00.
 - .2 Cast-in-Place Concrete, Section 03 30 00.
 - .3 Concrete Floor Finishes, Section 03 35 00.

1.2 EMBODIED CARBON DOCUMENTATION REQUIREMENTS

- .1 Refer to the GWP (global warming potential) maximum limits on embodied carbon referenced in the General Notes within the structural Contract Documents.
 - .1 The GWP limits are expressed in kg CO₂e per metric tonne (1000 kg) of fabricated rebar.
 - .2 The GWP limits represent stages A1-A3 in the life cycle analysis of the rebar production process.
- .2 Rebar is only to be sourced from suppliers that provide a Type III EPD (environmental product declaration) for their products. Industry average, Type II EPDs are not acceptable.
- .3 These limits apply to a minimum of 85% of the rebar in the project on a per tonne basis.

1.3 STANDARDS, CODES AND ACTS

- .1 Conform to the Ontario Building Code 2012 under Ontario Regulation 332/12, including Ontario Regulation 88/19 and any applicable acts of any authority having jurisdiction and the following:
 - .1 Manual of Standard Practice (2020), Reinforcing Steel Institute of Canada (RSIC).
 - .2 CAN/CSA-A23.1 - Concrete Materials and Methods of Concrete Construction, Canadian Standards Association.
 - .3 CSA STANDARD A23.3 - Design of Concrete Structures, Canadian Standards Association.
 - .4 CSA G30.18 – Carbon Steel Bars for Concrete Reinforcement, Canadian Standards Association.

- .5 ASTM A1064/A1064M – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete, ASTM International.
- .6 CSA W186, Welding of Reinforcing Bars in Reinforced Concrete Construction, Canadian Standards Association.
- .7 CSA-G279 - Steel for Prestressed Concrete Tendons, Canadian Standards Association.
- .2 Where there are differences between the specifications, drawings, codes, standards or acts, the most stringent shall govern.

1.4 TOLERANCES

- .1 Perform fabrication and setting so that completed work will be within the tolerances set out in CSA Standard A23.1, and RSIC Manual.
- .2 These tolerances are acceptable with regard to structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

1.5 QUALIFICATIONS

- .1 Welding Reinforcement
 - .1 The organization and personnel undertaking the welding of reinforcement shall be qualified by the Canadian Welding Bureau under the requirements of CSA-W186.

1.6 SAMPLES AND ASSISTANCE

- .1 General
 - .1 Supply samples of all materials and the following, the cost of which shall be paid for by this trade.
- .2 Reinforcement
 - .1 Provide the Consultant access to the reinforcement and precast concrete fabricator's plant. Inform the Consultant of the period during which fabrication will be undertaken.
 - .2 Cut samples of reinforcing steel designated by the Consultant from steel shipped to jobsite. Replace cut reinforcement or splice where permitted by the Consultant. Maintain an adequate supply of representative steel to permit immediate replacement of steel removed from the site as test specimens.
 - .3 Cut samples of mechanical splices and welded reinforcement as directed by the Consultant. Replace mechanical splices and welded reinforcement cut out for testing.
 - .4 Coordinate sampling and testing so that test results are received by the Consultant before concrete is placed in the members from which the samples are taken.

1.7 SUBMITTALS

.1 Embodied Carbon Documentation Submittal:

- .1 Refer to the GWP (global warming potential) maximum limits on embodied carbon referenced in the General Notes within the structural Contract Documents.
 - .1 The GWP limits are expressed in kg CO₂e per metric tonne (1000 kg) of fabricated rebar.
 - .2 The GWP limits represent stages A1-A3 in the life cycle analysis of the rebar production process.
- .2 Rebar is only to be sourced from suppliers that provide a Type III EPD (environmental product declaration) for their products. Industry average, Type II EPDs are not acceptable.
- .3 These limits apply to a minimum of 85% of the rebar on the project on a per tonne basis.

.2 Submit opening information, shop drawings for reinforcement, and certificates for review by the Consultant:

- .1 Refer to Section 01 30 00.
- .2 All submissions to be in digital pdf format. Leave room on drawings for the stamps of the Consultants. Check and sign before submission.

.3 Opening Information:

- .1 Prior to detailing reinforcement, submit drawings of the structure showing formed holes, openings, recesses and sleeving required under all Sections.
- .2 Review typical details on structural drawings with respect to openings in walls, slabs, openings at tiebacks, sleeve and conduit placement in concrete structures.
- .3 For slabs and vertical sleeves through beams, dimension openings, recesses and sleeves, and relate to suitable grid lines.
- .4 For horizontal sleeves through beams, provide elevation with sleeve location, dimensioned to grid lines, or nearest support, and top of beam.

.4 Shop Drawings for Reinforcement

- .1 After Consultant has reviewed and returned opening drawings, prepare reinforcement placing drawings and bar lists taking into account all openings and recesses.
- .2 Prepare placing drawings to a minimum scale of 1:50 in a clear complete manner that will permit placing of reinforcement to be performed without reference to contract drawings. Do not reproduce the structural drawings.
- .3 Detail reinforcement in accordance with the contract documents, CAN/CSA-A23.1 and detailing standards in RSIC Manual.
- .4 Except as noted otherwise on the drawings, provide standard hooks on reinforcement in accordance with CSA Standard A23.3.
- .5 Provide templates of column dowels to be fully butt welded to structural steel base plates under Section 05 12 00.

- .6 Amongst other items, indicate the following:
 - .1 Bar sizes
 - .2 Spacing
 - .3 Location and quantities of reinforcing
 - .4 Mesh
 - .5 Chairs
 - .6 Spacers
 - .7 Hangers
 - .8 Identify each bar with a code mark corresponding to the bar lists.
- .7 Detail sections to fully illustrate placement of reinforcement at areas such as openings, change of levels, spandrels, stairs and wherever else required.
- .8 Large scale detail sections at areas of congested steel such as at intersections of beams and columns, column splices or wherever else required.
- .9 Placing sequence for reinforcement such as intersections of beams and beams, slabs and beams and within flat and two-way slabs.
- .10 Minimum clearances between reinforcement and minimum concrete protection to reinforcement.
- .11 Location and embedment of dowels.
- .12 Location, number and type of support accessories, including support bars suitably sized and spaced to rigidly support the weight of reinforcement and construction loads.
- .13 Details of bending, cutting or placing to special tolerances.
- .14 Details of bending procedures for 45M and 55M bars.
- .15 Location and details of reinforcement at separation strips.
- .5 Shop Drawings for Welding Reinforcement
 - .1 Submit installation drawings showing, amongst other items, location, type and size of welds, welding procedures and techniques, stamped as approved by the Canadian Welding bureau.
- .6 Certificates
 - .1 Mill certificates are to be reviewed by the testing agency. Their review comments submitted to Consultant for records.
 - .2 Steel of Canadian Manufacture: Mill test certificates properly correlated to the reinforcement used for fabrication.
 - .3 Steel of other than Canadian Manufacture: Test data that each size and grade of reinforcement proposed meets specification requirements. Reinforcement approved for use by the Consultant shall be identified in a manner suitable to the Consultant. Only steel that has been approved will be accepted on jobsite.
 - .4 Weldable Reinforcement: Chemical composition and verification of weldability.
 - .5 Submit code marks or symbols used on reinforcement of each manufacturer so that Consultant may readily identify grades and sizes of reinforcement.

.7 Substitutions

- .1 Substitution of different size bars permitted only upon written approval of Consultant.

- .8 Contractor to submit to the Consultant and the Architect, detailed quality control measures for placement of reinforcing in accordance with structural drawings. They're to include methodology and qualifications of persons performing this work. These measures are to be independent of Consultant's and testing agency's review and performed prior to Consultant's review.

PART 2 – PRODUCTS

2.1 MATERIALS

.1 Reinforcement

- .1 Deformed steel to CSA G30.18 and to the material specification shown on the drawings.
- .2 Reinforcement to be welded shall conform to the material recommendations contained in CSA-W186.
- .3 Grade 400W weldable reinforcement shall have maximum yield stress of 525 MPa and maximum yield strain of 0.5%. Grade 500W weldable reinforcement shall have a maximum yield stress of 625 MPa and a maximum yield strain of 0.35%.

.2 Welded Wire Fabric

- .1 Conform to ASTM A1064/A1064M.

.3 Synthetic Fiber Reinforcement

- .1 Synthetic Macrofibers: Polypropylene and polyethylene fibers conforming with the requirements of ASTM C1609 and ASTM C1550. Acceptable products are TUF-STRAND SF as supplied by Euclid Chemical. Minimum dosage 1.8 kg/m³.
- .2 Synthetic Microfibers: Monofilament polypropylene micro-fibers for concrete reinforcement conforming to ASTM C1116 such as PSI FIBERSTRAND 150 by Euclid Chemical. Minimum dosage 0.4 kg/m³.

.4 Support Accessories

- .1 Chairs, bolsters or spacers of sufficient strength to rigidly support the weight of reinforcement and construction loads. In the case of concrete exposed to view or weather the accessories shall be such that no metal is permitted to come closer than 38 mm from a formed face and 50 mm from a trowelled surface. Use precast concrete supports for exposed concrete beams and soffits and concrete cast against soil.

.5 Headed Anchor Ends

- .1 Headed anchor ends shall develop the full capacity of the rebar in tension per CSA A23.3, CL. 7.1.4

- .1 Fusion-welded HRC 110/120/150 series T-headed bars by Head Reinforcement Corp. or approved equivalent.

PART 3– EXECUTION

3.1 FABRICATION

- .1 Fabricate reinforcing in accordance with CAN/CSA-A23.1.
- .2 Identify with a metal tag each bar with code mark corresponding to that appearing on bar list.
- .3 Bend reinforcement once only and at room temperature. Do not straighten or rebend reinforcement. Do not use bars with kinks or bends not shown on the drawings.
- .4 Replace bars which develop cracks or splits.

3.2 PLACING

- .1 Prior to concreting, place reinforcement, support and secure against displacement in accordance with the requirements contained in RSIC Manual and to the tolerances specified in CSA-A23.1. Tolerances shall be non-cumulative.
- .2 Conform to requirements shown for concrete cover to reinforcement.
- .3 Place reinforcement accurately and secure against displacement by using annealed iron wire ties or clips, or as otherwise specified, at intersections. Tack welding of reinforcement to secure in place will not be permitted.
- .4 Secure reinforcement in walls using sufficient spacers on each face to maintain the requisite distance between reinforcement and wall face and so that vertical bars are plumb. Provide a minimum of 10 mm diameter spreader bars spaced at 2 m centres in both directions.
- .5 Set column and wall dowels prior to concreting with wooden templates or other approved means.
- .6 Where toppings are placed on waterproof membranes, vapour barriers and the like, prevent reinforcement or tie wire contacting these items.
- .7 Do not drive or force reinforcement into fresh concrete.
- .8 Preassemble column and beam cages as necessary. Do not "spring" or bend ties and stirrups in order to place longitudinal reinforcement.
- .9 Pre-tie reinforcement for footings and lower into place so as not to disturb the soil at founding elevation.

3.3 REVIEW

- .1 At their discretion, the Consultant will review the reinforcing steel once it has been placed for general conformity with the contract documents.
- .2 Notify the Consultant a minimum of two working days in advance of the date of the proposed review.
- .3 The Consultant's review does not relieve the Contractor of its responsibility for correctly placing and adequately supporting the reinforcing steel, and shall not be regarded as a component of the Contractor's quality control program.

3.4 FIELD BENDING

- .1 Do not field bend reinforcement except where indicated or authorized in writing by Consultant.
- .2 When field bending is authorized, bend without heat, applying a slow and steady pressure.
- .3 Replace bars which develop cracks or splits.

3.5 FIBRE REINFORCING

- .1 Where no reinforcement is shown, provide TUF-Strand SF Synthetic Structural Fibres, or equivalent, at a minimum concentration of 1.8kg/m³ in slabs on grade or toppings 60mm in thickness or greater.

3.6 WELDED WIRE FABRIC

- .1 Supply welded wire fabric in flat sheets on grade.
- .2 Lap ends and sides of fabric not less than 150 mm.

3.7 CONSTRUCTION JOINTS

- .1 Obtain approval from the Consultant for locating and details of construction joints not shown.
- .2 Continue reinforcement through the joint in its normal position. Add additional reinforcement across the joint as shown or directed.

END OF SECTION 03 20 00

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Provide all material and labour required for the completion of the Contract. Breakdown of Work by Section is for guidance only and is not necessarily complete.
- .2 Work Furnished and Installed:
 - .1 Cast-in-place concrete.
- .3 Work Furnished but not Installed:
 - .1 Concrete for masonry including lintels, band courses and piers.
- .4 Related Work Specified Elsewhere:
 - .1 Concrete Formwork and Falsework, Section 03 10 00.
 - .2 Concrete Reinforcement, Section 03 20 00.
 - .3 Concrete Floor Finishes, Section 03 35 00.
 - .4 Backfilling below base course beneath slabs and behind walls under Section 31 23 23.13.
 - .5 Sub-grade material including moisture barrier, Section 31 23 23.13.
 - .6 Grouting beneath base plates bearing on masonry, Section 04 05 16.
 - .7 Lifting of structural steel plates, Section 05 12 00.

1.2 ENVIRONMENTAL / SUSTAINABLE DESIGN REQUIREMENTS

- .1 Refer to the GWP (global warming potential) benchmark and target values referenced in the General Notes within the structural Contract Documents.
 - .1 Submit Type III EPD (environmental product declaration) documents for each mix referenced in the Contract Documents.
 - .2 GWP targets may consider carbon mineralization in concrete: Concrete that has undergone active carbonation treatment during mixing such that carbon dioxide (CO₂) is injected during mixing and chemically converted into a mineral. The concrete may undergo mix optimization whereby the strength enhancement property of the mineralized CO₂ is used to adjust the cementitious materials content so long as the optimized concrete mix meets the concrete performance criteria required in the Contract Documents. Provide concrete producer's certificate outlining quantity, location and supplier of carbon dioxide. This technology is a complementary approach to reducing the GWP of concrete mixes. Acceptable technologies: CarbonCure Technologies.

1.3 STANDARDS, CODES AND ACTS

- .1 Conform with the Ontario Building Code 2012 under Ontario Regulation 332/12, including Ontario Regulation 88/19 and any other applicable acts of any authority having jurisdiction and the following (latest edition, including any supplements):
 - .1 CAN/CSA-A23.1, Concrete Materials and Methods of Concrete Construction, Canadian Standards Association.

- .2 CAN/CSA-A23.3, Design of Concrete Structures for Buildings, Canadian Standards Association.
- .3 CAN/CSA-A3000, Cementitious Materials Compendium, Canadian Standards Association.
- .4 CAN/CSA-A3001, Cementitious Materials for Use in Concrete, Canadian Standards Association.
- .5 ASTM C260, Standard Specification for Air-Entraining Admixtures for Concrete, ASTM International.
- .6 ACI-347 - Guide to Formwork for Concrete, American Concrete Institute.
- .7 CAN/CSA-S269.3 - Concrete Formwork, Canadian Standards Association.
- .2 Where there are differences between the specifications, drawings, codes, standards or acts, the most stringent shall govern.

1.4 TOLERANCES

- .1 Perform placing operations so that completed work will be within the tolerances set out in CAN/CSA-A23.1.
- .2 These tolerances are acceptable with regard to visual and structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

1.5 CONCRETE MIX DESIGN

- .1 Design of Mix
 - .1 Design the mix in accordance with CSA Standard A23.1 so that concrete will be homogeneous, uniformly workable, and readily placeable into corners and angles of forms and around reinforcement by the methods of placing and consolidation employed on the work, but without permitting materials to segregate or excessive free water to collect on the surface. The concrete, when hardened, shall have the qualities specified.
 - .2 Cement Type: Type GUL or GUb-SF, General Use.
 - .3 Specified Strength: As called for on drawings. Where walls are integral with columns such as foundation walls pour walls and columns with concrete of the specified strength for columns.
 - .4 Water Cement Ratio, Slump and Air Content: As called for on the Drawings. These requirements are for concrete at the point of placing.
 - .5 Admixtures: Type WN water reducing admixture.
 - .6 Supplementary Cementitious Materials:
 - .1 Slag Cement: Cementing materials for concrete may contain ground granulated blast-furnace slag (GGBFS).
 - .2 Fly Ash: Cementing materials for concrete may contain fly ash.
 - .3 Do not use recycled concrete aggregate in slabs or in concrete exposed to view. Except as noted, recycled concrete may constitute up to 100% of the coarse aggregate for concrete.
 - .7 Use of calcium chloride is not permitted.

- .8 Corrosion inhibiting admixture. Refer to drawings for scope.
- .9 CO₂ mineralization: Supply CO₂ mineralized concrete, such that post-industrial carbon dioxide (CO₂) is injected into the concrete like an admixture and chemically converted into a mineral. The concrete may undergo mix optimization whereby the strength enhancement property of the mineralized CO₂ is utilized to adjust cementitious content, pending that the optimized concrete mix meets concrete performance requirements as outlined in this specification document. Acceptable technologies: CarbonCure Technologies.
 - .1 The injection and subsequent mineralization of CO₂ meets the requirements of ASTM C494 Type S admixture.
 - .2 For Canadian projects, see CAN/CSA-A23.1 Annex S, Concrete made with carbon dioxide as an additive (revised June 2018)
- .2 Design concrete mixes to meet the humidity requirements of the finishes installed on the concrete. Refer to architectural drawings and specifications for finishes schedules.

1.6 SAMPLES AND ASSISTANCE

- .1 General
 - .1 Supply samples of all materials and the following, the cost of which shall be paid for by this trade.
- .2 Concrete Test Cylinders
 - .1 Cooperate in the execution of the concrete cylinder testing program. Furnish concrete required, protect specimens against injury and loss, and assist in the sampling and storage of specimens.
 - .2 Sample concrete and cast cylinders in accordance with CAN/CSA-A.23.1 where directed by the Consultant.
 - .3 In accordance with requirements of CAN/CSA-A.23.1, provide storage facilities for the initial 24 hours of site storage of all cylinders and the subsequent site storage of field cured cylinders. Suitably equip the 24 hour storage facility with humidity and temperature control equipment and maximum/minimum thermometers. It shall be sufficiently large to handle the maximum number of cylinders required at any one time.
 - .4 If required, provide sufficient field curing storage facilities so that cylinders representing the various areas can be safely stored in locations representing the curing conditions for those areas. Move the field-cured cylinder storage facilities from area to area as the work progresses.
- .3 Soil or Rock Inspection
 - .1 Assist the testing company or soils investigation firm to make their inspections or tests.
- .4 Cold Weather Concreting Plan
 - .1 Submit for review a plan for cold weather concreting. Included as a minimum:
 - .1 Slag replacement level to be used in the mix design.
 - .2 Curing period for concrete selected if accelerators are to be used to reduce the length of time winter heat is required.

- .3 Method of application of winter heat to the concrete and soil for the initial curing period, be it through construction of a heated enclosure or application of radiant, hydronic heaters such as Ground Heaters® or approved equivalent.
- .4 Method of protection of the concrete and soil for the balance of the curing period, be it through the use of insulating blankets, straw, fill or other methods.
- .5 Method of pre-heating of embedded elements such as reinforcing steel and cast-in inserts.

1.7 SUBMITTALS

- .1 Environmental Product Declarations:
 - .1 Provide Type III EPDs for all concrete mixes used on the project.
 - .2 If CO₂ mineralization is used, provide documentation verifying the following:
 - .1 Quantity, location and and supplier of chemically sequestered CO₂.
 - .2 Total GWP of mixes using injected and mineralized CO₂.
- .2 Submit the following for review by the Consultant:
 - .1 Certified mix designs for each type of concrete to be used, stating the specific location, using gridlines as a reference, or structural element for which the mix applies.

1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 00 and the Waste Reduction Workplan
- .2 Use excess concrete for: additional paving, post footing anchorage, swale rip-rap reinforcing, mud slab, flowable fill, footing bottom, retaining wall footing ballast, storm structure covers, underground utility pipe kickers, storm pipe flared end section, toe wash protection, shoulder and toe outfall restraints for temporary erosion pipes, and the like.
- .3 Use trigger operated spray nozzles for water hoses.
- .4 Designate a cleaning area for tools to limit water use and runoff. Cleaning area should be a portion of the site which is be paved at a later date.
- .5 Carefully coordinate the specified concrete work with weather conditions.
- .6 Ensure emptied containers are sealed and stored safely for disposal away from people.
- .7 Prevent plasticizers, water-reducing agents and air-entraining agents from entering drinking water supplies or streams. Using appropriate safety precautions, collect liquid or solidify liquid with an inert, non-combustible material and remove for disposal. Dispose of all waste in accordance with applicable local, provincial and national regulations.
- .8 Choose least harmful, appropriate cleaning method which will perform adequately.

PART 2 – PRODUCTS

2.1 MATERIALS

- .1 Concrete
 - .1 Conform to CAN/CSA-A.23.1.
- .2 Carbonation of concrete: Concrete that has undergone treatment with carbon dioxide (CO₂) during mixing, such that CO₂ is chemically sequestered into concrete as solid minerals. Acceptable technologies: CarbonCure Technologies (www.carboncure.com, 902-442-4020).
- .3 Coarse Aggregate: from locally quarried non-alkali reactive rock, mineral or air-cooled blast furnace slag
- .4 Recycled Concrete Coarse Aggregate: Clean, hard, strong, durable particles, free of absorbed chemicals, coatings and other fine materials, crushed from concrete having a compressive strength not less than 35 MPa
- .5 Low density aggregate for insulating concrete: Conform to CAN/CSA-A23.1 and ASTM C332 group I group II
- .6 Blended Hydraulic Cement: Conform to CAN/CSA A3001
- .7 Supplementary Cementing Materials:
 - .1 Type F Fly Ash to CAN/CSA-A23.5
 - .2 Cementitious Hydraulic Slag to CAN/CSA-A363
- .8 Water: Conform to CAN/CSA-A23.1
- .9 Admixtures: Air entraining agents or water reducing admixtures conforming to CSA CAN3-A266.1.
- .10 Chemical admixtures: to ASTM C494. Consultant to approve accelerating or set retarding admixtures during cold and hot weather placing.
- .11 Concrete retarders: to ASTM C494 water based, low VOC, solvent free. Do not allow moisture of any kind to come in contact with the retarder film.
- .12 Curing Compound: Water based curing compound conforming to CSA Standard A.23.1. such as Safe Cure & Seal (J-18, J-19) by Dayton/Richmond or approved equivalent.
- .13 Grout Beneath Base Plates: Non-shrink flowable grout In-Pakt or equal having a compressive strength at 28 days of at least 35 MPa. Where grout is exposed to view or weather, use non-ferrous grout.
- .14 Corrosion Inhibitors:
 - .1 Corrosion Inhibiting Admixture complying with ASTM C1582 and ANSI/NSF 61 such as MCI 2005NS, as supplied by Cortec Corporation. The corrosion inhibiting admixture should be dosed at fixed rate of 1 litre per cubic meter.
 - .2 DCI Corrosion Inhibiting Admixture, as supplied by W.R. Grace & Co. Dosage in accordance with manufacturer's recommendations, but at least 11 litres per cubic metre.
- .15 Bonding agent: Sikadur 32 Hi-Mod epoxy-based protective coating and bonding adhesive, as supplied by Sika Canada, or approved equivalent.
- .16 Non-shrink grout: minimum 30 MPa grout, as supplied by CPD Construction Products, or approved equivalent.

- .17 Micro-fibers: Monofilament polypropylene micro-fibers for concrete reinforcement confirming to ASTM C1116 such as PSI FIBERSTRAND 150 by Euclid Chemical.

PART 3 – EXECUTION

3.1 FOOTINGS

- .1 Refer to drawings for soil criteria for bearing of footings.
- .2 Founding elevations, based upon the report of the sub-surface investigation, at which it is presumed these conditions pertain are shown.
- .3 Founding elevations must be verified by the sub-surface investigation firm before footings are placed.
- .4 See Section 31 23 23.13 for excavation and backfilling requirements for footings and for the procedure of adjusting contract price where changes to foundations are required.
- .5 Note that the existing foundations along the are shown to be founded above the new footings.
- .6 Install footings adjacent to existing footings in the sequences indicated, and against undisturbed soil as shown, and so that the stability of the existing footings and existing slabs on grade are maintained at all times.
- .7 Prior to proceeding with the work, determine the exact founding elevations of existing footings adjacent to the new work. Report these findings to the Consultant before proceeding further.
- .8 If, upon excavating to the elevations shown, the required soil conditions are not fulfilled, or if they are fulfilled at a higher elevation, the Consultant will provide instructions as to how to proceed.
- .9 Keep a record of footing founding elevations.
- .10 Construct footings in a particular area commencing from the lowest footing elevation and proceeding to the higher elevation.
- .11 Proceed in a similar manner for continuous footings to walls which vary in founding elevation by commencing with the continuous footing at the lowest elevation.
- .12 Remove water, disturbed soil or loose rock or foreign matter from footing excavations before placing concrete. Do not permit the soil at founding elevations to soften due to the presence of water in the excavations or construction activity.
- .13 During cold weather, prevent soil or rock adjacent to and beneath all footings from freezing. Do not pour footings on frozen soil on soil which has been allowed to freeze and thaw. If the soil at specified founding elevations is frozen or was frozen and thawed, remove affected material and found footings on unaffected soil with the required characteristics at no extra cost to the Owner.
- .14 If the actual founding elevations differ from those shown by more than 600 mm, the Contractor may be reimbursed for the extra cost of such work, except as stipulated below, or shall credit the Owner for deletions based upon the unit prices quoted for concrete reinforcing steel and formwork. Extras or credits shall be calculated by establishing the total net extras or credit for the footings for each material and then multiply by the appropriate unit price.

- .15 Extras will be paid only if upon excavating to the specified founding elevations, it is found that soil conditions do not meet the requirements set forth. No extras will be paid if soil becomes weakened through agencies within the control of the Contractor, such as through the action of ground water, inadequate protection from weather, construction activity, over-excavation, or through undermining by the installation of nearby electrical or mechanical services.
- .16 Depending upon the degree of defective workmanship, corrective measures may include such measures as redesign of footings and their increase in size as the Consultant may direct. Corrective measures required to overcome defective workmanship shall be made at no extra cost to the Owner.
- .17 Where excavations for mechanical or electrical services, pits adjacent to foundations and the like encroach upon a 7 in 10 slope between corners of footings and bottom corners of excavations, lower footings a suitable amount so as not to exceed the 7 in 10 slope at no extra cost to the Owner.

3.2 CONSTRUCTION JOINTS

- .1 Obtain approval from the Consultant for location and details of construction joints not shown.
- .2 The maximum length of a concrete pour shall be 40 m.
- .3 The maximum height of a concrete pour shall be 5 m.

3.3 PLACING CONCRETE

- .1 Conform to requirements of CAN/CSA-A.23.1 and the following:
- .2 Immediately before placing concrete, clean forms and reinforcement of foreign matter.
- .3 During hot weather conditions, do not use concrete mixed more than 1 hour after introduction of mixing water or 1-1/2 hours during other periods.
- .4 Allow 24 hours minimum after placing concrete in columns, piers or walls before placing concrete in beams or slabs supported thereon.
- .5 Ensure waterproof membranes are not damaged during placing of concrete over them.
- .6 Place concrete on steel joist and steel deck floors in a manner that avoids piling up of concrete. Do not drop concrete directly from buckets, but employ suitable means of distribution. Wet down deck during hot weather prior to concreting.
- .7 Remove concrete spilled onto forms around hoisting equipment before depositing concrete in these areas.
- .8 Co-ordinate with general contractor placement procedures to ensure the humidity levels in concrete meet warranty requirements of the finishes at time of installation.

3.4 PROTECTION

- .1 General
 - .1 Conform to the requirements of CAN/CSA-A.23.1 and the following to protect freshly deposited concrete from freezing, premature drying and extremes of temperature. Maintain concrete with minimal moisture loss at a relatively constant temperature for the period of time necessary for the hydration of the cement and to achieve the specified strength of the concrete.

.2 Cold Weather Concreting

- .1 Between the 15th of October of any year and the 15th of April of the following year, provide on hand and ready for use all equipment necessary for adequate cold weather protection and curing before concrete placement is begun.
- .2 When fresh concrete is to be cast against existing concrete, prevent the loss of heat by extending the protection for the fresh concrete at least 600 mm over the existing.
- .3 Insulate, or enclose within the protective housing, tie rods, reinforcement or metal which projects from the concrete being protected.
- .4 Construct enclosures tight and safe for wind and snow loadings.
- .5 Maintain housing, enclosures and supplementary heat in place for entire period of protection, except that sections may be temporarily removed as required to permit placing additional forms or concrete provided the uncovered concrete is not permitted to freeze. Make up time lost from the required period of protection at the required temperature before protection is discontinued and removed.
- .6 Dispose heating units to avoid heating concrete locally or drying it excessively. Avoid high temperature and dry heating within enclosures.
- .7 Take particular care to maintain edges and corners of concrete at the required temperature owing to their greater vulnerability to freezing.

.3 Hot weather concreting

- .1 Between the 15th of April and the 15th of October, the contractor shall establish and follow procedures to ensure proper mix temperatures and curing conditions as specified in CSA A23.1.

.4 Slabs on Grade

- .1 See Slabs on Grade Section for additional cold weather protection execution requirements for placing concrete slabs on grade.

.5 Protection of Completed Work

- .1 At all times during the work, protect exposed concrete, exposed masonry and other exposed members from staining or becoming coated with concrete leakage due to continuing concreting operations. Members which become coated may be classed as defective work by the Consultant.
- .2 Protect exposed members from staining due to rusting of reinforcement projecting beyond construction joints.
- .3 Take suitable measures to prevent spalling and cracking damage occurring to the structure due to water freezing in expansion joints, small holes, slots, depressions and take suitable measures to prevent damage occurring to foundations and the like due to frost action in the soil or backfill.
- .4 The application of de-icing salts on completed work is not permitted.
- .5 During the curing period, take suitable measures to protect the surface of the concrete from pitting and loss of fines due to rain.
- .6 Co-ordinate with general contractor concrete protection measures to ensure the humidity levels in concrete meet warranty requirements of the at time of installation.

3.5 SLABS ON GRADE

.1 General

- .1 Do not place concrete slabs on grade until the specified sub-floor material has been placed, inspected and approved.
- .2 Do not place concrete on a frozen sub-grade, or on one that contains frozen materials.
- .3 Do not place concrete on a sub-grade that has been frozen and thawed until the sub-grade has been reviewed by the Consultant and approved. If, in the Consultant's opinion, the safe bearing capacity of the sub-grade has been reduced to below 24 kPa, remove the affected materials and replace with compacted granular fill at no additional cost to the Owner.
- .4 Refer to drawings for preparation of base to receive slab.
- .5 Place bond breaker, minimum of 1 layer of building paper between edges of slab on grade and abutting surfaces.
- .6 Upon approval of the placement of the sub-floor material and setting of reinforcing, place and consolidate concrete and finish and cure as specified herein.
- .7 Where two pour method is specified on the drawings, upon approval of the placement of the sub-floor material, place and consolidate a uniform thickness of slab on grade concrete to within 40 mm of top. Coordinate with Section 03 20 00 the immediate placement of reinforcement on top of the first layer of concrete. Place, consolidate, finish and cure the final 40 mm thickness of slab to the tolerances specified.

.2 Joints

- .1 Where slabs abut adjacent construction, provide a layer of joint filler between.
- .2 Saw-cut slabs on grade exposed to view in the finished building into panels as shown with a maximum length between saw-cuts equal to 25 times the slab thickness. e.g. a 100 mm thick slab will required saw-cuts at 2.5m c/c. Arrange panels as shown or to the Consultant's approval.
- .3 Carry out cutting in accordance with recommendations contained in ACI 302.1R but in any event between 6 and 18 hours after placement of concrete.
- .4 After a curing period of at least 90 days, and after the building is under permanent temperature control, fill saw-cuts with a compatible joint sealer or filler.
- .5 Ensure that joints to be filled are clean, dry and free of foreign matter.
- .6 Fill joints in slabs subject to wheeled traffic with SikaLoadFlex 524 EZ or equivalent.
- .7 Fill joints in slabs not subject to wheeled traffic with Sikaflex 1CSL or equivalent.
- .8 Ensure the joint filler or sealer is flush with the adjacent concrete; a concave profile on the top of the joint is unacceptable.
- .9 Mask edges of saw-cuts to prevent concrete floors from becoming stained.
- .10 Construction joints may be provided in slabs on grade so that pours on any one day may be kept to reasonable sizes. Locate construction joints to the Consultant's approval.

- .11 In exposed concrete, provide a reglet at construction joints of the approximate width of a saw-cut and fill the reglet as specified for saw-cuts.

3.6 GROUTING BENEATH BASE PLATES

- .1 Grout beneath plates bearing on concrete with an approved non-shrink flowable grout. Conform with the manufacturer's directions for mixing and placing grout. Completely fill voids below plates. Fill voids left by shims after shims are removed.
- .2 During cold weather, preheat base plates and footings and maintain temperature at minimum 12 degrees C. for 6 days after grouting.

3.7 REINFORCED BLOCK LINTELS

- .1 Supply and place concrete and reinforcing steel for reinforced block lintels in accordance with the requirements of Typical Detail and this specification.
- .2 Accurately place and secure reinforcement in the cavity prior to concreting. Trowel top of lintel as required to permit laying of succeeding block course.

3.8 OPENINGS THROUGH COMPLETED MEMBERS

- .1 Do not cut openings through completed members without the Consultant's approval.
- .2 If directed, where the location of openings is approved, mark their position on each side of members to be perforated. In the case of slabs over 75 mm thick, cut two-thirds of the thickness by drilling from the top and remaining one-third by drilling from the bottom. Drill walls similarly from each side.
- .3 Where the location of openings is approved, locate the reinforcing by x-ray, cover meter or other positive means and adjust the location of the opening so that no reinforcement is cut unless specifically approved otherwise in writing by the Consultant.
- .4 Maintain the axis of the hole at right angles to the surface of the member.
- .5 In the case of precast concrete slabs, holes shall be cut or drilled only by the precast concrete fabricator.

3.9 MAKING GOOD

- .1 Where directed by the Consultant, make good temporary openings left in concrete construction around pipes, ducts and the like using a mortar of the same proportions as the surrounding work. Reinforce mortar with mesh or the like where openings exceed 75 mm. Roughen existing surfaces to receive mortar or apply suitable bonding agent such that mortar will be securely bonded to existing concrete.

3.10 TREATMENT OF FORMED SURFACES

- .1 General
 - .1 After stripping for forms, the bared surface of concrete will be inspected by the Consultant. Do not proceed with repairs or surface treatment to concrete prior to the Consultant's inspection.
 - .2 After the Consultant's inspection, remove or cut back 25 mm, bolts, ties, nails or other metal not specifically required for construction purposes.
 - .3 Where no serious defects are revealed by the Consultant's inspection, cut out areas of moderate honeycombing to sound concrete. Saturate with water and fill with cement mortar of the same general composition as that used in the concrete.

- .4 Where serious defects are found, such as large voids or extensive honeycombing, repair the defect as directed by the Consultant.
- .5 Where surfaces are to be plastered, damp-proofed, waterproofed or similarly finished, remove fins, ridges or bulges which would interfere with the application of the final finishes.
- .6 Remove traces of form lining compound from concrete surfaces which may affect the bonding of following surface application.

END OF SECTION 03 30 00

PART - 1 GENERAL

1.1 SUMMARY

- .1 This Section includes requirements for exterior cast-in-place concrete, including forming and reinforcing.

1.2 RELATED REQUIREMENTS

- .1 Section 31 23 33.01 Excavating, Trenching and Backfilling

1.3 REFERENCE STANDARDS

- .1 American Concrete Institute (ACI)
 - .1 ACI 301, Specifications for Concrete Construction
 - .2 ACI PRC-309-05: Guide for Consolidation of Concrete
 - .3 ACI SP-66, ACI Detailing Manual 2004.
- .2 ASTM International (ASTM)
 - .1 ASTM A123/A123M Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, latest version.
 - .2 ASTM A143/A143M, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement, latest version.
 - .3 ASTM A641 / A641M, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire, latest version.
 - .4 ASTM A884/A884M Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement, latest version.
 - .5 ASTM C920 Standard Specification for Elastomeric Joint Sealants, latest version.
 - .6 ASTM D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non extruding and Resilient Bituminous Types), latest version.
- .3 CSA Group (CSA)
 - .1 CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete, latest version.
 - .2 CAN/CSA A23.3, Design of Concrete Structures), latest version.
 - .3 CAN/CSA A3000, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005), latest version.
 - .4 CAN/CSA G30.18-[09(R2014)], Billet-Steel Bars for Concrete Reinforcement, latest version.
 - .5 CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel, latest version.
 - .6 CAN/CSA O86, Engineering Design in Wood.
 - .7 CSA O121, Douglas Fir Plywood.
 - .8 CSA O151, Canadian Softwood Plywood.
 - .9 CAN/CSA O325.0, Construction Sheathing.
 - .10 CSA O437 Series, Standards for OSB and Waferboard.
 - .11 CSA S269.1, Falsework and Formwork.
 - .12 CAN/CSA S269.3, Concrete Formwork.
 - .13 CSA W186, Welding of Reinforcing Bars in Reinforced Concrete Construction, latest version.

- .4 Reinforcing Steel Institute of Canada (RSIC)
 - .1 RSIC, Reinforcing Steel Manual of Standard Practice, latest version.
- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for proprietary materials used in Cast-In-Place Concrete and additives and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS Safety Data Sheet (SDS)
- .3 Shop Drawings:
 - .1 Shop drawings shall be stamped and signed by professional engineer registered or licensed in Ontario unless otherwise indicated.
 - .2 Complete assembly: where indicated, submit shop drawings that encompass for all parts of the finished concrete assembly including any reinforcing, footings, or embedded items as well as formwork.
 - .1 Comply with detailed requirements below for reinforcing, formwork, etc.
 - .3 Reinforcing: submit shop drawings for concrete reinforcing.
 - .1 Comply with RSIC Manual of Standard Practice.
 - .2 Indicate placing of reinforcement and:
 - .3 Detail lap lengths and bar development lengths to CAN/CSA A23.3.
 - .4 Indicate position and size of openings in slabs and walls. Coordinate with trades requiring openings.
 - .4 Formwork: submit shop drawings for formwork only if indicated.
 - .1 Comply with CSA S269.1.
 - .2 Indicate formwork design data: permissible rate of concrete placement, and temperature of concrete, in forms.
 - .3 Indicate sequence of erection and removal of formwork.
 - .4 When slip forming is used, submit details of equipment and procedures for review by Consultant.
 - .5 Indicate method and schedule of construction, shoring, stripping and re-shoring procedures, materials, arrangement of joints, special architectural exposed finishes, ties, liners, and locations of temporary embedded parts.
 - .6 Indicate sequence of erection and removal of formwork.
 - .5 Accessories: include any indicated or required accessories on the relevant shop drawings.
- .4 Provide manufacturer's product data for each type of concrete indicated and do not proceed without written acceptance.
 - .1 Include source of fly ash, if applicable.
- .5 Quality Assurance Submittals:
 - .1 Submit in accordance with Section 01 45 00 - Quality Control
 - .2 Mill Test Report: upon request, submit to Consultant certified copy of mill test report of reinforcing steel, minimum 4 weeks prior to beginning reinforcing work.

- .3 Upon request submit in writing to Consultant proposed source of reinforcement material

1.5 QUALITY ASSURANCE

- .1 Provide to Consultant, 4 weeks minimum prior to starting concrete work, valid and recognized certificate from plant delivering concrete.
- .2 Quality Control Plan: provide written report to Consultant verifying compliance concrete in place meets performance requirements.
- .3 Mock-Ups:
 - .1 Provide site mock-up for architectural finished concrete indicating forming methods and materials, and procedures proposed to achieve architectural finish in accordance with Section 01 45 00 - Quality Control, and to comply with following requirements, using materials indicated for completed work:
 - .1 Build mock-ups in location and of size as agreed by Owner and Consultant.
 - .2 Obtain Owner's and Consultant's acceptance of mock-ups before starting construction; mock-up used throughout construction period and used as standard of acceptance for subsequent architectural concrete work.
 - .3 Mock-up may form part of permanent structure when accepted by Owner and Consultant; repair or replace unacceptable mock-ups at no additional cost to Owner.
 - .4 In presence of Consultant, damage part of exposed face for each finish, colour, and texture, and demonstrate materials and techniques proposed for repairs to match adjacent undamaged surfaces.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Formwork, reinforcing and accessories:
 - .1 Delivery and Acceptance Requirements:
 - .1 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.
 - .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
 - .2 Storage and Handling Requirements:
 - .1 Store materials in off-ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .2 Concrete:
 - .1 Concrete hauling time: deliver to site of Work and discharge within 120 minutes maximum after batching.
 - .1 Modifying maximum time limit without receipt of prior written agreement from Consultant and concrete producer as described in CSA A23.1/A23.2 is prohibited.
 - .2 Deviations shall be submitted for review with submittals.
 - .2 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.

1.7 AMBIENT CONDITIONS

- .1 Placing concrete during rain or weather events damaging to concrete is prohibited.
- .2 Protect newly placed concrete from rain or weather events in accordance with CSA A23.1/A23.2.

- .3 Cold weather protection:
 - .1 Maintain protection equipment, in readiness on Site.
 - .2 Use such equipment when ambient temperature below 5°C, or when temperature may fall below 5°C before concrete cured.
 - .3 Placing concrete upon or against surface at temperature below 5°C is prohibited.
- .4 Hot weather protection:
 - .1 Protect concrete from direct sunlight when ambient temperature above 27°C.
 - .2 Prevent forms of getting too hot before concrete placed. Apply accepted methods of cooling not to affect concrete adversely.
- .5 Protect from drying.

PART - 2 PRODUCTS

2.1 DESIGN CRITERIA

- .1 Alternative 1 - Performance: to CSA A23.1/A23.2 and as described in MIXES of PART 2 - PRODUCTS.

2.2 PERFORMANCE CRITERIA

- .1 Quality Control Plan: ensure concrete supplier meets performance criteria of concrete as established by Consultant and provide verification of compliance as described in PART 1 - QUALITY ASSURANCE.

2.3 REINFORCING MATERIALS

- .1 Fabricate reinforcing steel in accordance with CSA A23.1/A23.2 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.
 - .1 Upon request, provide Consultant with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis, minimum 4 weeks prior to beginning reinforcing work.
 - .2 Upon request inform Consultant of proposed source of supplied material.
- .2 Reinforcing steel: weldable low alloy steel deformed bars to CSA G30.18.
- .3 Cold-drawn annealed steel wire ties: to ASTM A1064/A1064M.
- .4 Deformed steel wire for concrete reinforcement: to ASTM A1064/A1064M.
- .5 Welded steel wire fabric:
 - .1 Plain or deformed as indicated, in accordance ASTM A1064/A1064M and fabricated from as drawn steel wire into flat sheets; sizes as indicated on Drawings.
 - .2 Finish:
 - .1 Galvanized: Hot dip galvanized after welding having Class A coating in accordance with ASTM A1064/A1064M.
 - .2 Provide in flat sheets only, unless otherwise indicated.
- .6 Galvanizing of non-prestressed reinforcement: to ASTM A123/A123M, Coating Grade 85, minimum zinc coating 610 g/m².
 - .1 Protect galvanized reinforcing steel with chromate treatment to prevent reaction with Portland cement paste.
 - .2 If chromate treatment carried out immediately after galvanizing, soak steel in aqueous solution containing minimum 0.2% by weight sodium dichromate or 0.2% chromic acid.

- .1 Temperature of solution minimum 32 degrees and galvanized steels immersed for minimum 20 seconds.
- .3 If galvanized steels at ambient temperature, add sulphuric acid as bonding agent at concentration of 0.5% to 1%.
 - .1 No restriction applies to temperature of solution.
- .4 Chromate solution sold for this purpose may replace solution described above, provided if of equivalent effectiveness.
 - .1 Provide product description as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .7 Chairs, bolsters, bar supports, spacers: to CSA A23.1/A23.2.
- .8 Tie wire: 1.5 mm diameter annealed wire.
- .9 Mechanical splices: subject to review by Consultant.
- .10 Plain round bars: to CSA G40.20/G40.21.

2.4 FORMWORK MATERIALS

- .1 For concrete without special architectural features, use wood and wood product formwork materials meeting CAN/CSA O86.
- .2 For concrete with special architectural features, use formwork materials to CSA A23.1/A23.2.
- .3 Rigid insulation board: to CAN/ULC-S701.
- .4 Tubular column forms: round, spirally wound, polyethylene impregnated virgin kraft interior layer and a waxed exterior, internally treated with release material.
- .5 Form ties:
 - .1 Snap ties complete with plastic cones and light grey concrete plugs.
- .6 Form liner:
 - .1 Plywood: high density overlay Canadian Softwood Plywood to CSA O151, grade and thickness as determined by formwork designer or as indicated on the drawings.
- .7 Form release agent: Proprietary, non volatile material not to stain concrete or impair subsequent application of finishes or coatings to surface of concrete, derived from agricultural sources, non petroleum containing.

2.5 CONCRETE MATERIALS

- .1 Portland Cement: Normal Portland Cement in accordance with CAN/CSA A3000, Type GU Sulphate Resisting Portland Cement in accordance with CAN/CSA A3000, Type MS.
- .2 Contractor may propose supplementary cementing materials per CAN/CSA A3001 subject to Consultant's review.
- .3 Water: to CSA A23.1/A23.2.
- .4 Other concrete materials: to CSA A23.1/A23.2.

2.6 MIXES

- .1 Alternative 1 - Performance Method for specifying concrete: to meet indicated performance criteria to CSA A23.1/A23.2.
 - .1 Ensure concrete supplier meets performance criteria as established below and provide verification of compliance as described in PART 3 - VERIFICATION.
 - .2 Contractor and supplier to propose plastic state criteria suitable for the work, including uniformity, workability, finish-ability and set time, subject to Consultant's review.:
 - .3 Provide concrete mix to meet following hard state requirements:

- .1 Durability and class of exposure: C-2.
- .2 Compressive strength at 28 days: 32 MPa minimum.
- .3 Intended application: Landscape elements: curbs, gutters, sidewalks, fencepost footings, etc.
- .4 Aggregate size 20 mm maximum.
- .4 Concrete supplier's certification.
- .5 Provide quality management plan to ensure verification of concrete quality to specified performance.

2.7 OTHER MATERIALS

- .1 Expansion Joint Filler: pre-moulded bituminous fibre board, conforming to ASTM D1751.
- .2 Joint sealer/filler: grey to ASTM C920, Type M, Grade NS.

PART - 3 EXECUTION

3.1 PREPARATION

- .1 Verify lines, levels, and centres before proceeding with formwork and ensure dimensions agree with drawings.
- .2 Excavate and prepare base for footings in accordance with Section 31 23 33.01.
 - .1 Obtain Consultant's review for use of mud slabs or similar where not indicated on drawings.
 - .2 Obtain Consultant's review for use of earth forms framing openings not indicated on drawings.
- .3 Provide Consultant 48 hours notice before each concrete pour.
 - .1 Contractor shall not proceed with pour until formwork and reinforcing have been reviewed by Consultant or designate.
 - .2 Contractor to arrange attendance by representative of designated testing and inspection company.

3.2 FORMWORK

- .1 Refer to architectural drawings for concrete members requiring architectural exposed finishes.
- .2 Do not place shores and mud sills on frozen ground.
 - .1 Provide site drainage to prevent washout of soil supporting mud sills and shores.
- .3 Fabricate and erect formwork in accordance with CAN/CSA S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA A23.1/A23.2.
- .4 Align form joints and make watertight.
 - .1 Keep form joints to minimum.
- .5 Use 25 mm chamfer strips on external corners and 25 mm fillets at interior corners, joints, unless specified otherwise.
- .6 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
- .7 Construct forms for architectural concrete, and place ties as indicated or as directed.
 - .1 Joint pattern not necessarily based on using standard size panels or maximum permissible spacing of ties.

- .8 Build in anchors, sleeves, and other inserts required to accommodate Work specified in other sections.
 - .1 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.
- .9 Form liners:
 - .1 Line forms for exposed faces of walls, abutments, wingwalls, piers and pylons: do not stagger joints of form lining material and align joints to obtain uniform pattern.
 - .2 Secure lining taut to formwork to prevent folds.
 - .3 Pull down lining over edges of formwork panels.
 - .4 Ensure lining is new and not reused material.
 - .5 Ensure lining is dry and free of oil when concrete is poured.
 - .6 If concrete surfaces require cleaning after form removal, use only pressurized water stream so as not to alter concrete's smooth finish.
 - .7 Cost of lining is included in price of concrete for corresponding portion of Work.
- .10 Clean formwork in accordance with CSA A23.1/A23.2, before placing concrete.

3.3 REINFORCING

- .1 Place reinforcing steel as indicated on placing drawings and in accordance with CSA A23.1/A23.2.
- .2 Do not field bend or field weld reinforcement except where indicated or authorized by Consultant.
 - .1 When field bending authorized, bend without heat, applying slow and steady pressure.
 - .2 Replace bars which develop cracks or splits.
- .3 Use plain round bars as slip dowels in concrete.
 - .1 Paint portion of dowel intended to move within hardened concrete with one coat of asphalt paint.
 - .2 Apply thick even film of mineral lubricating grease when paint is dry.
- .4 Touch up damaged and cut ends of galvanized reinforcing steel with compatible finish to provide continuous coating.
- .5 Prior to placing concrete, obtain review or inspection of reinforcing material and placement.
- .6 Maintain cover to reinforcement during concrete pour.

3.4 CONCRETE INSTALLATION

- .1 Do cast-in-place concrete work in accordance with CSA A23.1/A23.2.
- .2 Sleeves and inserts:
 - .1 Cast in sleeves, ties, slots, anchors, reinforcement, frames, conduit, bolts, water-stops, joint fillers and other inserts required to be built-in.
- .3 Hand trim sides and bottoms and remove loose earth from earth forms before placing concrete.
- .4 During concreting operations:
 - .1 Development of cold joints not allowed.
 - .2 Concrete delivery and handling to facilitate placing with minimum of rehandling, and without damage to existing structure or Work.
- .5 Consolidation:

- .1 Internal or external vibrators or both shall be used to thoroughly consolidate concrete at the point of deposit within 15 minutes of placing.
- .2 Each layer of concrete shall be vibrated. Vibrators shall extend into the previous layer to produce a homogenous mixture at the layer interface.
- .3 Vibration shall not be used to make the concrete flow or to spread the concrete more than 1.5 m from the point of deposit.
- .6 Protect previous Work from staining.
- .7 Clean and remove stains prior to application of concrete finishes.

3.5 FINISHES

- .1 Formed surfaces exposed to view: shall be finished as indicated in accordance with CSA A23.1/A23.2.
- .2 Depressions in slabs between high spots shall not be greater than 5 mm below a 3 m straight edge and in accordance with CSA A23.1/A23.2, Clause 7.6.1.2 and Table 21, finish classification Class B.
- .3 Slabs to receive mortar bed: screed to correct grade and provide broomed texture.
- .4 Equipment pads: provide smooth trowelled surface.
- .5 Pavements, walks, curbs and exposed site concrete:
 - .1 Screed to plane surfaces and use aluminum floats.
 - .2 Provide round edges and joint spacings using standard tools.
 - .3 Trowel smooth and provide indicated non-slip finish.

3.6 CONTROL JOINTS

- .1 Cut or form control joints in concrete work on grade at locations indicated, to CSA A23.1/A23.2 and install specified joint sealer/filler, if specified.

3.7 EXPANSION AND ISOLATION JOINTS

- .1 Install pre-moulded joint filler in expansion and isolation joints full depth of slab flush with finished surface to CSA A23.1/A23.2.

3.8 CURING

- .1 Use curing compounds compatible with applied finish on concrete surfaces free of bonding agents and to CSA A23.1/A23.2.

3.9 FORMWORK REMOVAL

- .1 Leave formwork in place for minimum of 2 days after placing concrete unless otherwise directed.
- .2 Remove formwork when concrete has reached 70 % of its 28 day design strength or minimum period noted above, whichever comes later, and replace immediately with adequate reshoring if applicable.
- .3 Provide necessary reshoring of members where early removal of forms may be required or where members may be subjected to additional loads during construction as required.
- .4 Re-use formwork only with written agreement of Owner and/or Consultant and subject to meeting the requirements of CSA A23.1/A23.2.

3.10 SITE TOLERANCES

- .1 Concrete slab finishing tolerance to CSA A23.1/A23.2.

3.11 FIELD QUALITY CONTROL

- .1 Concrete testing: to CSA A23.1/A23.2 by testing laboratory designated and paid for by Consultant.

3.12 CLEANING

- .1 Conform to Section 01 74 00.
- .2 Use trigger operated spray nozzles for water hoses.
- .3 Designate cleaning area for tools to limit water use and runoff.
- .4 Waste Management:
 - .1 Do not use excess concrete on site.
 - .2 Provide appropriate area on job site where concrete trucks can be safely washed.
 - .3 Divert admixtures and additive materials from landfill to approved official hazardous material collections site.
 - .4 Disposal of unused admixtures and additive materials into sewer systems, into lakes, streams, onto ground or in other location posing health or environmental hazard is prohibited.
- .5 Final cleaning:
 - .1 Ensure concrete has fully cured before cleaning.
 - .2 Clean concrete of marks, stains, or efflorescence using only purpose made cleaners that pose no environmental risk on site or downstream.

END OF SECTION 03 30 00.09

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Coordination:
 - .1 Provide all material and labour required for the completion of the Contract. Breakdown of Work by Section is for guidance only and is not necessarily complete.
- .2 Related Work Specified Elsewhere:
 - .1 Concrete Formwork and Falsework, Section 03 10 00.
 - .2 Cast-in-Place Concrete, Section 03 30 00.
 - .3 Concrete Reinforcing, Section 03 20 00.

1.2 STANDARDS, CODES AND ACTS

- .1 Conform with the Ontario Building Code 2012 under Ontario Regulation 332/12, including Ontario Regulation 88/19 and any applicable acts of any authority having jurisdiction and the following:
 - .1 CAN/CSA-A23.1-04, Concrete Materials and Methods of Concrete Construction, Canadian Standards Association.
- .2 Where there are differences the specifications and drawings and the codes, standards or acts, the most stringent shall govern.

1.3 TOLERANCES

- .1 Perform finishing operations so that completed work will be within the tolerances set out in CSA Standard A.23.1 and as listed below:
 - .1 5 mm in 3 m determined by a straightedge held parallel to and in contact with the surface.
 - .2 The rate of change from the actual to specified surface shall not exceed 8 mm in 3 metres.
- .2 The rate of change from the actual to specified surface shall not exceed 8 mm in 3 metres.
- .3 These tolerances are acceptable with regard to visual and structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.
- .4 Note the need for accurate alignment of perimeter slab edges both horizontally and vertically.

1.4 WARRANTIES

- .1 Floors
 - .1 The Contractor hereby warrants all floor surfaces finished under this Section for a period of two years against dusting, disintegrating, and/or other defects within the control of the Contractor.

1.5 SUBMITTALS

.1 Cambers

- .1 Submit a proposal for review by the Consultant how the specified camber in slabs and beams are to be achieved.

PART 2 – PRODUCTS

2.1 MATERIALS

- .1 Concrete Materials: in accordance with Section 03 20 00 and 03 30 00.

PART 3 – EXECUTION

3.1 GENERAL

- .1 Conform to CSA Standard A.23.1.
- .2 Finish the top or final surface of concrete by screeding, floating and trowelling as defined in CSA Standard A.23.1 and in accordance with the architectural final finish requirements. Unless specified otherwise, steel trowel to CSA Standard A.23.1.
- .3 Verify floor finish tolerances and cambers after each slab section has been cast and before any formwork has been removed. For beams measure along their centre lines. For slabs measure along grid and centre lines. Measuring points to include the point of maximum camber and shall be no further than 3000 mm apart.
- .4 Survey floors including beams three weeks after all shoring has been removed. Measure along same points as in sub clause above.
- .5 Use suitable techniques to finish abutting pours at joints to eliminate "humping". If humping occurs, grind the joint down level to the surrounding surface.
- .6 Where the finish is not of the quality specified, remove ridges, undulations, projections at construction joints and areas of carbonation and scaling by methods approved by the Consultant.
- .7 Cure concrete in accordance with CSA Standard A.23.1.

3.2 JOINTS AT ELECTRICAL DUCTS

- .1 Where electrical trunks or junction boxes finish flush with the concrete base slab or topping, hand trowel the concrete surface a distance 150 mm each side of ducts so that the concrete finishes flush with the top of the duct without bumps or depressions. Tool the concrete surface on either side of electrical ducts to provide a groove 10 mm wide by 25 mm deep to receive mastic.

3.3 CRACK REPAIR

- .1 Prior to completion of the project and in any case not sooner than 28 days after concrete has been placed, examine concrete floor surfaces and repair all major cracks in them. Rout cracks out with mechanical router to 13 mm square approximate cross section. Then clean and fill cracks in same manner as saw-cuts in slab on grade.

3.4 SEALING

- .1 Seal floor slabs which have no applied finishes such as vinyl tile and like with a compound equal to Florseal, as manufactured by Sika Group. Apply in strict accordance with the manufacturer's directions. Apply one coat 28 days after concrete is placed and apply a final coat just prior to completion of the project.

3.5 TOPPINGS

- .1 Conform to requirements of CSA Standard A.23.1 for bonded toppings and the following:
 - .1 Set rigid screeds accurately by transit level to provide level or sloped floors as required. "Wet" screed methods will not be permitted.
 - .2 Bring base to same temperature as surrounding atmosphere before placing topping. Minimum temperature shall be 10 degrees C.
 - .3 Apply toppings over existing floors waterproofing membranes metal deck insulation as specified above, excepting as follows:
 - .1 The base slab need not be kept moist nor shall a cement slurry be applied.
 - .2 Ensure that the membrane or insulation is not damaged due to any concreting operation.

3.6 JOINT IN SLABS ON GRADE

- .1 Where slabs abut adjacent construction, provide a layer of joint filler between.
- .2 Saw-cut slabs on grade exposed to view in the finished building into panels as shown with a maximum length between saw-cuts of 3 m. Arrange panels as shown or to the Consultant's approval.
- .3 Carry out cutting in accordance with recommendations contained in ACI 302 but in any event between 6 and 18 hours after placement of concrete.
- .4 After a period of at least 28 days, fill saw-cuts with mortar containing cement, sand and latex bonding agent. Ensure that joints to be filled are clean, dry and free of foreign matter.
- .5 Mask edges of saw-cuts to prevent concrete floors from becoming stained.
- .6 Construction joints may be provided in slabs on grade so that pours on any one day may be kept to reasonable sizes. Locate construction joints to the Consultant's approval.
- .7 In exposed concrete, provide a reglet at construction joints of the approximate width of a saw-cut and fill the reglet as specified for saw-cuts.

3.7 JOINTS IN SLABS ON GRADE WITH TERRAZZO TOPPINGS

- .1 Construct slabs in panels not exceeding 3 m in length. Arrange construction joints to fall below a metal parting strip in the terrazzo.

3.8 JOINTS IN CONCRETE METAL DECK

- .1 Where shown, provide 40 mm deep saw-cuts in the concrete fill on metal deck. Conform to clauses for joints in slabs on grade for all other aspects of these saw-cuts.

END OF SECTION 03 35 00

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Provide all material and labour required for the completion of the Contract. Breakdown of Work by Section is for guidance only and is not necessarily complete.
- .2 Work Furnished and Installed:
 - .1 Structural steel work, including steel joists and bridging.
- .3 Related Work Specified Elsewhere:
 - .1 Grouting beneath column bases and bearing assemblies on concrete members: Section 03 30 00.
 - .2 Grouting beneath baseplates bearing on masonry: Section 04 05 16.
 - .3 Concrete reinforcement: Section 03 20 00.
 - .4 Reinforcing edges of openings in metal deck that are not larger than 450mm in roof deck and 300mm in floor deck: Section 05 31 00.
 - .5 Paint and steel preparation for paint systems: Section 09 91 00
- .4 Work Furnished but not Installed:
 - .1 Anchor bolts, bearing assemblies and other structural steel connections to be cast into concrete.
 - .2 Bearing plates and related connections for metal deck to be built into masonry or concrete.
 - .3 Loose lintels, shelf angles and plates to be built into masonry.

1.2 EMBODIED CARBON DOCUMENTATION REQUIREMENTS

- .1 Refer to the GWP (global warming potential) maximum limits on embodied carbon referenced in the General Notes within the structural Contract Documents.
 - .1 The GWP limits are expressed in kg CO₂e per metric tonne (1000 kg) of fabricated steel.
 - .2 The GWP limits represent stages A1-A3 in the life cycle analysis of the steel production process.
- .2 Structural steel is only to be sourced from suppliers that provide a Type III EPD (environmental product declaration) for their products. Industry average, Type II EPDs are not acceptable.
- .3 These limits apply to a minimum of 85% of the steel on the project on a per tonne basis.

1.3 STANDARDS, CODES AND ACTS

- .1 Conform to the Ontario Building Code 2012 under Ontario Regulation 332/12, including Ontario Regulation 88/19 and any applicable acts of any authority having jurisdiction and the following (latest edition including any and all supplements):
 - .1 CSA S16 - Limits States Design of Steel Structures, Canadian Standards Association.
 - .2 CSA G164 - Hot Dip Galvanizing of Irregularly Shaped Articles, Canadian Standards Association.

- .3 CSA S136 - North American Specifications for the Design of Cold Formed Steel Structural Members (using the Appendix B provisions applicable to Canada)
- .4 CSA W47.1 - Certification of Companies for Fusion Welding of Steel Structures, Canadian Standards Association.
- .5 CSA W48 – Filler Metals and Allied Materials for Metal Arc Welding, Canadian Standards Association.
- .6 CSA W59 – Welded Steel Construction (Metal Arc Welding), Canadian Standards Association.
- .7 CSA W178.1 – Certification of Welding Inspection Organizations, Canadian Standards Association.
- .8 CSA W178.2 – Certification of Welding Inspectors, Canadian Standards Association.
- .9 CISC/CPMA 1-73a – A Quick-drying One-coat Paint for Use on Structural Steel, Canadian Institute of Steel Construction.
- .10 SSPC SP1, Solvent Cleaning, The Society for Protective Coatings.
- .11 SSPC-SP2, Hand Tool Cleaning, The Society for Protective Coatings
- .12 SSPC-SP6/NACE No. 3, Commercial Blast Cleaning, The Society for Protective Coatings
- .13 SSPC-SP7/NACE No. 4, Brush-Off Blast Cleaning, The Society for Protective Coatings
- .14 SSPC-SP10/NACE No. 2, Near-White Blast Cleaning, The Society for Protective Coatings
- .15 SSPC-SP16, Brush-Off Blast Cleaning of Non-Ferrous Metals, The Society for Protective Coatings
- .16 ASTM D6386, Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
- .17 ASTM A780 / A780M Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- .18 CISC Code of Standard Practice for Structural Steel
- .2 Where there are differences between the specifications, drawings, standards, codes or acts, the most stringent shall govern.

1.4 TOLERANCES

- .1 Conform to erection tolerances specified in CSA S16 Clause 29.3 and as follows:
 - .1 Fit-up and alignment of structural steel at the Warm Up / Lounge is critical for proper interfacing with the mass timber elements. Contractor to ensure that shop drawings are developed in tandem with the relevant sub-trades.
 - .2 Moment splice connections for Warm Up / Lounge steel shall be designed to adequately control beam rotations so that cantilever beam tip deflections are well controlled and do not exceed the specified limits.
- .2 Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

1.5 QUALIFICATIONS

- .1 Be certified under the requirements of Division 1, or Division 2.1 of CSA Standard W47.1.

1.6 DESIGN

.1 General

- .1 Design connections, joists, bridging, trusses and the like in accordance with the requirements of CSA S16 and the following for the loads shown or implied.
- .2 Design cold-formed steel members, their connections, bracing and the like in accordance with CSA Standard S136 for the loads shown or implied.
- .3 Design calculations shall be carried out by a professional engineer licensed to practice in the Province of Ontario.

.2 Connections

- .1 Use types of shop or field connection shown, or in absence of such indication, use most appropriate type of connection.
- .2 Design of connections shall include not only those between columns, beams, girders, trusses and braces, but also between such members as spandrel angles and beams, hangers, stiffeners, etc., and their supporting members (be they steel or concrete).
- .3 Design connections to safely withstand the combined effects of shear, moment and torque at applicable design stresses.
 - .1 Moment splices for framing in the Warm Up / Lounge area shall be designed as fully welded or slip critical connections.
- .4 Do not weld galvanized members without the Consultant's approval.
- .5 Design bracing member connections for positive adjustability.
- .6 Design connections that are exposed to weather so that moisture, dirt and the like cannot gain entry to the interior of hollow built-up members.
- .7 Design and detail connections so as not to interfere with architectural clearance lines or finishes.
- .8 Where connections between beams and columns and the like result in loss of bearing to the metal deck, precast, wood deck or the like, design and provide support as required.
- .9 Design and provide end bearing connections of inclined members and joists such that the bearing plane between them and their supporting members is horizontal.
- .10 Design connections of cold-formed structural members for the loads shown or implied.
 - .1 Design connections between galvanized members and cold-formed members to employ powder actuated fasteners, unless noted otherwise
- .11 Design connections that are to be cast into concrete to provide for the maximum deviation that can occur in erection and based on the following:
 - .1 Specified steel erection tolerances.
 - .2 Maximum permissible tolerances in the location of inserts cast into concrete of plus or minus 15 mm in any direction.

- .12 Design interconnection between built up members as noted, or where note noted, interconnect as required to ensure adequate capacity for the design forces shown or implied in the drawings.
- .13 Design connection of single angle members for the forces shown or implied in the drawings, such that connection are made to the same leg each end by welding or with a minimum of two bolts.
- .3 Joists
 - .1 Limit roof joist deflection due to specified live load to 1/300 of span and deflection due to total specified load to 1/240 of the span in areas not supporting ceilings.
 - .2 Limit roof joist deflection due to specified live load to 1/360 of span and deflection due to total specified load to 1/240 of the span in areas supporting ceilings.
 - .3 Limit floor joist deflection due to specified live load to 1/360 of span and deflection due to total specified load to 1/240 of the span.
 - .4 Design joists parallel to and adjacent to more rigid supports with increased stiffness to avoid abrupt changes in deflection. Maintain deflections in deck equivalent to criteria above for the direction perpendicular to the joist span.
 - .5 Joists supporting folding partitions to be designed for live load deflection of 1/1150 of span per ASTM E557.
 - .6 Where designated as being hot-dip galvanized, design joists so that they are not subject to permanent deformations due to the galvanizing process. Joist weights may be affected.
 - .7 Joist Shoe Shear Connections: Unless noted otherwise, design joist shoes to transfer a minimum of 4 kN of shear perpendicular to the line of the joist into supporting beams and walls.
 - .8 Design roof joists, related bridging and anchorages to safely resist net uplift forces shown, but a minimum of 0.5 kPa.
 - .9 Design joists supporting moveable partitions so that live load deflection when subjected to full live load including partition stacked at any point, or fully extended, shall not exceed 15 mm.
 - .10 Design joists to support a factored suspended point load of 2.5 kN at any panel point. This load is in addition to the loads shown on plan.
 - .11 Where ducts or services are shown to pass through or between joists, design and locate web members and bridging to accommodate the sizes and runs of ducts and services shown.
 - .12 Design and connect joists to furnish lateral support to the chords or flanges of supporting steel members. Anchor joists to such members, and at opposite ends, by connections capable of withstanding a horizontal force of not less than 10 per cent of end reaction of joist.
 - .13 Where tie joist are indicated, design top and bottom chords and connect to columns to safely develop tension loads shown or a minimum of 25 kN in tension or compression.
 - .14 Design anchorage of each line of bridging to walls and other supporting structural steel members to safely resist forces shown, but as a minimum develop the safe capacity of the bridging members in tension.

- .15 Design and provide end-bearing connections of inclined joists such that the bearing plane between the inclined joists and their supporting members is horizontal.
- .16 Design bearing of joists on masonry so that the maximum working stress on the masonry does not exceed 1.25 kPa.

1.7 SUBMITTALS

- .1 Coordinate submittal requirements with Section 01 30 00
- .2 Environmental Product Declaration (EPD) Submittal:
 - .1 Submit Type III EPDS for steel procured for the project.
- .3 Submit for review by the Consultant the following shop drawings:
 - .1 Standard Connection Design Details – when requested.
 - .2 Non-standard and Exposed Connection Design Details.
 - .3 Erection Diagrams.
 - .4 Include the outline of foundation walls with anchor bolt shop drawings for context.
 - .5 Shop Details – when requested.
 - .6 Erection Procedures – when requested.
 - .7 Field Work Details.
 - .8 Joist Details.
 - .9 Calculations – when requested.
 - .10 Do not reproduce the structural drawings to serve as erection or setting drawings.
 - .11 Shop drawings shall bear the signature and stamp of a qualified professional engineer licensed to practice in the Province of Ontario responsible for design of their respective work. Alternatively, a sealed memo to same effect can be provided.
- .4 Standard Connection Design Details
 - .1 Connection design details shall be prepared before the preparation of shop details and submitted to the Consultant for review that the intent of the design is met.
- .5 Non-standard and Exposed Connection Design Details
 - .1 Moment and torsion connections.
 - .2 All connections exposed to view.
 - .3 Connection design details shall bear the signature and stamp of a qualified professional engineer licensed to practice in the Province of Ontario.
- .6 Erection Diagrams
 - .1 Amongst other items show the following:
 - .1 General arrangement of the structure including all steel load-resisting elements essential to the integrity of the completed structure
 - .2 Principal dimensions of the structure
 - .3 Piece marks
 - .4 Sizes of the members

- .5 Bearing details.
- .6 Holes.
- .7 Surface preparation, primer or other coatings.
- .8 Grades of steel.
- .9 Size and type of bolts and bolt installation requirements
- .10 Shop and field welds
- .11 Elevations of column bases
- .12 All necessary dimensions and details for setting anchor rods
- .13 Sliding expansion joint bearing pad details, including materials, size and thickness of pads, setting out dimensions and load capacity.
- .14 Required clearances and other details to receive correlative items
- .15 Any other information necessary for the assembly of the structure
- .2 Show necessary dimensions and details for setting structural steel bearings, anchorages, assemblies and the like where they interface with other building components.
- .3 Co-ordinate with shop drawings of cast-in-place concrete, masonry, miscellaneous metal work, metal deck and other interfacing work.
- .7 Shop Details
 - .1 Shop details shall provide complete information for the fabrication of various members and components of the structure, including the required material and product standards; the location, type, and size of all mechanical fasteners; bolt installation requirements; and welds.
- .8 Erection Procedures
 - .1 Erection procedures shall be prepared before erection and submitted to the Consultant for review.
 - .2 Erection procedures shall outline the construction methods, erection sequence, temporary bracing requirements, and other engineering details necessary for shipping, erecting, and maintaining the stability of the steel frame.
 - .3 Drawings and sketches that identify the location of permanent and temporary load-resisting elements essential to the integrity of the partially completed structure shall supplement erection procedures.
 - .4 Submit details of method proposed to apply and verify the magnitude of tension to bracing members within the specified tolerances.
 - .5 Submit procedures proposed when erection is carried out at temperatures greatly differing from 20 degrees C.
- .9 Fieldwork Details
 - .1 Sealed fieldwork details shall be submitted for review by the Consultant whenever modifications to the original details shown on shop drawings are required.
 - .2 Fieldwork details shall provide complete information for modifying fabricated members in the shop or on the job site. All operations required to modify the member shall be shown on the fieldwork details.

.10 Joist Details

- .1 Joist details shall be submitted to the Consultant for review.
- .2 Joist details shall bear the signature and stamp of a qualified professional engineer licensed to practice in the Province of Ontario
- .3 Amongst other items show the following:
 - .1 Specified loading
 - .2 Factored member loads
 - .3 Materials
 - .4 Member sizes
 - .5 Dimensions
 - .6 Spacers
 - .7 Welds
 - .8 Shoes
 - .9 Anchorages
 - .10 Bracing
 - .11 Bearings
 - .12 Field splices
 - .13 Bridging locations, sizes and connection details
 - .14 Camber
 - .15 Coatings

.11 Calculations

- .1 Submit calculations bearing the signature and stamp of a qualified professional engineer licensed to practice in the Province of Ontario and such further proof as may be necessary to show that non-standard connections and the like and truss connections and steel joist construction conform to the requirements set forth herein.

.12 Substitution

- .1 If the Contractor wishes to make substitutions for steel materials or sizes indicated, submit proposals with the tender with necessary calculations for review of the Consultant.

.13 Drawings for Inspection Company

- .1 Furnish inspection company with a copy of erection diagrams, shop details, erection procedures and fieldwork details bearing the Consultant's reviewed stamp.

.14 As-Built Drawings

- .1 Mark on 2 complete sets of final drawings any changes, additions or deletions that occur during the construction as a result of the Contractor's work, change orders or for any other reason.

- .2 If the Contractor wishes to make use of the structural CAD drawings, the cost of each drawing's CAD file is \$150, payable directly to Blackwell. The Contractor is required to sign a waiver stating the intended use prior to release of the drawings.
- .15 Mill Test Reports
 - .1 Submit copies of mill test reports properly correlated to the materials available to the testing agency for review and to the Consultant for records.

PART 2 – PRODUCTS

2.1 MATERIALS

- .1 Unless otherwise approved, all structural steels shall be produced in Canada, the United States or EU countries.
- .2 Rolled Wide Flange Sections: Conform to ASTM A992/A992M, $F_y=345\text{MPa}$, unless otherwise noted.
- .3 Rolled channels and angles: Conform to CAN/CSA-G40.21 350W, unless otherwise noted.
- .4 Steel plate, bars and rods: Conform to CAN/CSA-G40.21-04 300W, unless otherwise noted.
- .5 Seamless Pipe: Conform to ASTM A53/A53M.
- .6 Hollow Structural Sections: Conform to CAN/CSA-G40.21-04 Grade 350W, Class C
 - .1 ASTM A500 is not an acceptable alternate and shall not be used as a substitute unless approved; all HSS sections will require review to be resized (increased wall thickness or increased section size) if ASTM A500 is proposed. The cost of review shall be borne by the contractor.
 - .2 HSS produced to ASTM A1085 is an acceptable alternate to CSA G40.21 Grade 350W Class C.
- .7 Bolts, nuts and washers: ASTM F3125, grade A325, galvanized when used with galvanized material, and produced in Canada, the United States or EU countries.
- .8 Headed stud: Conform to CSA W59 Appendix H and with a tensile strength of 450 MPa and yield strength of 350 MPa.
- .9 Coated cold-formed steel: ASTM A653/A653M Grade 340, F_y 345 MPa.
- .10 Uncoated cold-formed steel: ASTM A1011/A1011M Grade 340 (Grade 50), $F_y=345\text{MPa}$.
- .11 Universal Shop primer: Phenolic Alkyd Primer
 - .1 Acceptable products:
 - .1 Devguard 4360 Low VOC Universal Primer.
 - .2 Sherwin Williams B50 Kem Bond HS Universal Metal Primer.
 - .3 PPG Amercoat 185H Universal Phenolic Primer.
- .12 Repair primer for application in the field:
 - .1 Water Based Acrylic Primer. Acceptable Products:
 - .1 PPG Devflex 4020PF Direct to Metal Primer
 - .2 Sherwin Williams Pro-Cryl B66-310 Series Universal Primer

- .3 PPG Pitt-Tech Plus 90-912 Series DTM Industrial Primer
- .13 Primer for steel to be galvanized and receive a paint finish:
 - .1 Acceptable products:
 - .1 Sherwin Williams B71Y1 DTM Wash Primer.
 - .2 Carboline Sanitile120 Heavy Duty Bonding Primer.
 - .3 PPG Pitt-Tech 90-712 Series DTM Primer.
- .14 Cold Galvanizing Coating for repair of galvanized surfaces:
 - .1 Acceptable Products:
 - .1 ZRC Zero-VOC Galvanizing Compound as manufactured by ZRC Worldwide, Marshfield, MA
 - .2 Aervoe Industries, Inc. 'Low VOC Cold Galvanize Coating 93% Zinc
 - .3 Tru-Galv Ultra Silver by HUB Industrial Supply 69% Zinc
- .15 Heavy bituminous coating for exterior steel extending below grade:
 - .1 WOHL Coatings BB-110 or equivalent.

PART 3– EXECUTION

3.1 WORKMANSHIP AND FABRICATION

- .1 Conform to CSA S16 and the following:
- .2 Camber
 - .1 Provide camber to beams and girders as noted on the drawings.
 - .2 Provide camber in a manner that will not reduce the safe load carrying capacity of the members.
 - .3 If no camber is indicated, orient the section so that any natural camber in the member counteracts the dead load deflection.
 - .4 Camber joists over the gym for total dead load deflection.
- .3 Provide holes to 15mm in diameter indicated at any time before shop drawings are reviewed, as required to permit the attachment of other materials.
- .4 Provide ceiling extensions for joist bottom chords as required.
- .5 Plates and shelf angles supporting masonry shall be continuous and extend full length of masonry openings. At splices, grind welds smooth where exposed to view.
- .6 Unless noted or required otherwise, provide a minimum 6mm thick cap plate on all HSS and other closed column sections. Galvanized HSS are to have vent holes as required.
- .7 Openings
 - .1 Conform to requirements shown for location, size, reinforcing and cutting of openings through structural members.
 - .2 Obtain written permission of Consultant prior to field cutting or altering of structural members not shown on the drawings.

.8 Galvanized Steel

- .1 Detail and fabricate steel such that it will not trap the galvanizing material.
- .2 Detail so that welding of galvanized material is not required.
- .3 Provide with vent holes as required.
- .4 Clean of all weld slag prior to galvanizing.
- .5 Upon completion of erection, touch up with cold galvanizing coating at all locations where galvanizing is damaged.

3.2 PROTECTION

- .1 Primers and paints used in multi-coat systems where a final shop or field paint finish is to be applied shall be selected and pre-approved by the Architect based on surface preparation, exposure conditions, and compatibility with other coatings.
- .2 Refer to Architectural Drawings and Specifications for locations of applicable paint and anti-corrosion systems.
 - .1 References:
 - .1 Section 09 91 00 - Painting
- .3 Black Steel
 - .1 This steel type applies to structural steel concealed from view in the finished building and not exposed to weather or high humidity environments.
 - .1 No cleaning or painting is required for this steel type.
- .4 DTM Primed/Finished Steel
 - .1 This steel type applies to exposed steel in the finished structure, with the exception of Architectural Grade steel (see below).
 - .1 Preparation: Clean structural steel in accordance with SSPC SP2, Hand Tool Cleaning
 - .2 Apply first coat of DTM within one hour following cleaning
 - .3 For finished steel, apply second coat in the field in accordance with the manufacturer's instructions.
- .5 Primed Steel – Architectural Grade
 - .1 This steel type applied to exposed AESS steel in the Warm Up / Lounge area.
 - .1 Clean structural steel in accordance with SSPC SP6, Commercial Blast Cleaning. [SSPC SP10 Near-White Blast Cleaning].
 - .2 Apply Universal shop primer within one hour following cleaning.
 - .3 Touch-up primer and top coats in accordance with Section 09 91 00.
- .6 Steel Encased in concrete or coated with spray applied fire proofing
 - .1 This steel type applies to structural steel which is to be encased in spray applied fire proofing or concrete.
 - .1 No cleaning or painting is required for this steel type.

.7 Galvanized Steel

.1 Major elements

.1 Locations as indicated

.2 Unless noted otherwise, this steel type applies to exterior structural steel which is fully or partially outside the building envelope, and interior structural steel which is exposed to moisture in the finished building but is not designated as “architectural”. Examples include, but are not limited to:

.1 Steel within the cavity of cavity walls

.2 lintels

.3 shelf angles

.4 plates, hangers, braces etc. outside the building envelope

.5 connection materials and inserts associated with the above.

.3 Fully galvanize, in accordance with CSA G164 to a minimum zinc coating of 600 g/m².

.4 Repair any damage to galvanizing arising from mechanical connections of deck or other attachments using specified cold galvanizing compound in accordance with ASTM A780.

.8 Provide two coats of heavy bituminous coating on all steel exterior to the building envelop that extends below grade, including where it is encased in concrete.

.9 Except for steel which is to be left uncoated, upon completion of erection, apply specified field primer to welds, bolts and at locations where original primer is damaged. Prepare steel in strict accordance with the manufacturers' recommendations. For galvanized steel, touch up with specified zinc rich coating.

.10 Protect all steel from damage during storage, transportation and erection.

.11 Protect weep holes at base of closed column sections that have base plates, but no cap plates.

.12 During cold weather, protect members from damage due to water freezing in confined areas.

.13 Provide drain holes in closed sections to prevent water build-up during erection.

3.3 ERECTION

.1 General

.1 Conform to requirements of CSA S16 and the following:

.2 Bracing members and anchor bolts shown are for the finished structure and may not be adequate to resist forces present during construction.

.3 Maintain temporary bracing until completion of entire structure including floor and roof decks, slabs, masonry walls and other elements which are part of the wind resisting system.

.4 Carry out erection operations, including installation of any temporary guying and shoring required, without loading portions of the existing structure already constructed in excess of its safe load carrying capacity.

- .5 During erection, forces or reactions in the steel frame members and their connections may exceed those on which the design is based.
 - .6 Determine the magnitude of such forces and reactions and take such measures as are necessary to ensure that the safety and stability of the structure is maintained until the entire structure, including floor and roof slabs is complete.
 - .7 Splices, other than those shown, shall not be permitted in members without the Consultant's approval. If approval is given to permit welded splices, they shall be non-destructively tested at no extra cost to the Owner.
 - .8 Report to the Consultant where members cannot be erected within the specified tolerances without modification or special procedures. Take corrective measures to the Consultant's approval.
- .2 Install bracing members by applying a nominal tension such that they will be initially under tension in the completed building.
- .3 Bearing on Concrete or masonry
- .1 Set steel bases and bearing assemblies true and level at the proper elevation so that upon grouting, they will have full bearing.
 - .2 Unless a specific method is shown, levelling devices or steel shimming may be used to support bases prior to grouting. Subsequent to grouting, loosen the leveling devices so that all loads pass only through the bases, or remove the steel shims so that the resulting voids can be fully grouted.
- .4 Joists
- .1 Anchor joists in accordance with CSA S16 and to safely resist the net uplift forces shown, but not less than 0.50 kPa.
 - .2 Supply special shoes or steel packing as required to bring joists to required bearing level.
 - .3 Until such time as the permanent anchorage system can maintain the joists in their correct position under wind and other loadings provide suitable temporary anchorage.
 - .4 Where drawings call for electrical and/or mechanical services to be recessed between joists, space and arrange joists and bridging to permit installation of services.
- .5 Lintels
- .1 Unless a reinforced block or concrete lintel is noted, provide loose steel lintels, as shown, over openings and recesses in masonry walls or partitions including those for mechanical or electrical services.
- .6 Openings
- .1 Conform to the requirements shown for location, size, reinforcing and cutting of openings through structural members.
 - .2 No openings through structural steel members will be permitted without the Consultant's approval.

3.4 ARCHITECTURALLY EXPOSED STRUCTURAL STEEL (AESS)

.1 General

- .1 Architecturally exposed steel (AESS) is all steel which is left exposed to view in the completed building in areas accessible to the public.
- .2 This section applies to any structural steel members noted on the contract drawings as AESS. All AESS members must also be identified by their Category.
- .3 This section pertains to the appearance, surface preparation and integration of AESS. Refer to the preceding sections for all technical requirements.

.2 Submittals

- .1 Shop Drawings detailing fabrication of AESS components:
 - .1 Provide erection drawings clearly indicating which members are considered as AESS members and their Category
 - .2 Include details that clearly identify all of the requirements listed in subsections .5 “Fabrication” and .9 “Erection” of this section. Provide connections for AESS consistent with concepts, if shown on the Structural Design Documents
 - .3 Indicate welds by standard CWB symbols, distinguishing between shop and field welds, and show size, length and type of each weld. Identify grinding, finish and profile of welds as defined herein
 - .4 Indicate type, finish of bolts. Indicate which side of the connection bolt heads should be placed
 - .5 Indicate any special tolerances and erection requirements.
 - .6 Show clearly the required fabrication tolerances on shop drawings. Show the required tolerances for setting embedded items on erection drawings.

.3 Quality Assurance

- .1 Fabricator Qualifications: In addition to those qualifications listed in other subsections of Division 5 “Structural Steel” Section, engage a firm competent in fabricating AESS similar to that indicated for this Project with sufficient production capacity to fabricate the AESS elements
- .2 Erector Qualifications: In addition to those qualifications listed in other Subsections of Division 5 “Structural Steel” Section, engage a competent Erector who has completed comparable AESS work.
- .3 Comply with applicable provisions of the following specifications and documents:
 - .1 CISC Code of Standard Practice, latest edition
- .4 Visual Samples when specified may include any of the following:
 - .1 3-D Rendering of specified element;
 - .2 Physical sample of surface preparation and welds;
 - .3 First off inspection: First element fabricated for use in finished structure subject to alterations for subsequent pieces.
 - .4 Mockups: As specified in Structural Design Document. Mockups are either scaled or full-scale. Mockups are to demonstrate aesthetic effects as well as qualities of materials and execution:

- .1 Mockups may have finished surface (including surface preparation and paint system)
 - .2 Architects approval of mockups is required before starting fabrication of final units;
 - .3 Mockups are retained until project is completed;
 - .4 Approval full-scale mockups may become part of the completed work.
- .4 Delivery, Storage, and Handling
 - .1 Ensure that all items are properly prepared, handled and/or packaged for storage and shipping to prevent damage to product.
 - .2 Erect finished pieces using softened slings or other methods such that they are not damaged. Provide padding as required to protect while rigging and aligning member's frames. Weld tabs for temporary bracing and safety cabling only at points concealed from view in the completed structure or where approved by the architect.
- .5 Fabrication
 - .1 For the special fabrication characteristics, see Table 1 – AESS Category Matrix.
 - .2 Fabricate and assemble AESS in the shop to the greatest extent possible. Locate field joints in AESS assemblies at concealed locations or as approved by the Architect.
 - .3 Fabricate AESS with surface quality consistent with AESS Category and visual samples, if applicable.
 - .4 Perform fabrication with special care and necessary straightening to maintain the condition of the material as described herein.
 - .5 Make copes, mitres and butt cuts in surfaces exposed to view within the closest possible tolerances consistent with structural shop equipment and practice. Plan erection sequence so that these tolerances can be maintained.
 - .6 Where the fit-up of adjacent members is such that permissible tolerances specified above may result in any unsightly joint, take special care to obtain a visual plane on the exposed surfaces. If both surfaces are exposed, detail joints in such a way as to minimize these unavoidable variations.
 - .7 All exposed edges of plates shall be universal mill or guided flame cut. Exposed cut edges of beam flanges shall be guided flame cut. Cut surfaces shall be equal in smoothness to a mill finish.
 - .8 Where bolted connections are shown, ensure that connections are neatly arranged with tight joints.
- .6 Shop Connections
 - .1 Bolted Connections: Make in accordance with Section 05 12 00. Provide bolt type and finish as specified and place bolt heads as indicated on the approved shop drawings.
 - .2 Welded Connections: Comply with CSA W59 and Section 05 12 00. Appearance and quality of welds shall be consistent with the category and visual samples if applicable. Assemble and weld built-up sections by methods that will maintain alignment of members to the tolerance of this subsection.

.7 Field Connections

- .1 Bolted Connections: Make in accordance with this section. Provide bolt type and finish as specified and place bolt heads as indicated on the approved shop drawings.
- .2 Welded Connections: Comply with CSA W59 and Section 05 12 00. Appearance and quality of welds shall be consistent with the Category and visual samples if applicable. Assemble and weld built-up sections by methods that will maintain alignment of members to the tolerance of this Subsection.
 - .1 Assemble and weld built-up sections by methods that will maintain alignment of axes. Verify that weld sizes, fabrication sequence, and equipment used for AESS will limit distortions to allowable tolerances.

.8 Welding

- .1 Form and weld all joints exposed to weather to exclude water by the use of "seal" welds.
- .2 Exposed welds, except filler welds and concealed welds, where clearances or fit of other items may so necessitate, shall be ground smooth and otherwise finished flush and even with adjacent surfaces. Grinding is not required for well formed fillet welds.
- .3 Grind bevel welds smooth, forming neat, well-made corners.

.9 Erection

- .1 The erector shall check all AESS members upon delivery for twist, kinks, gouges or other imperfections, which might result in rejection of the appearance of the member. Coordinate remedial action with fabricator prior to erecting steel.
- .2 Provide connections for temporary shoring, bracing and supports only where noted on the approved shop erection drawings. Temporary connections shown shall be made at locations not exposed to view in the final structure or as approved by the Architect. Handle, lift and align pieces using padded slings and / or other protection required to maintain the appearance of the AESS through the process of erection.
- .3 Set AESS accurately in locations and to elevations indicated, and according to CSA S16.
- .4 In addition to the special care used to handle and erect AESS, employ the proper erection techniques to meet the requirements of the specified AESS Category:
 - .1 AESS Erection tolerances: Erection tolerances shall meet the requirements of standard frame tolerances for structural steel per CSA S16, unless noted otherwise.
 - .2 Bolt Head Placement: All bolt heads shall be placed as indicated on the structural design. Where not noted, the bolt heads in a given connection shall be placed to one side
 - .3 Removal of field connection aids: Run-out tabs, erection bolts and other steel members added to connections to allow for alignment, fit-up and welding in the field shall be removed from the structure. Welds at run-out tabs shall be removed to match adjacent surfaces and ground smooth. Holes for erection bolts shall be plug welded and ground smooth where specified;
 - .4 Filling of connection access holes: Filling shall be executed with proper procedures to match architectural profile, where specified;

- .5 Field Welding: Weld profile, quality, and finish shall be consistent with Category and visual samples, if applicable, approved prior to fabrication.

.10 Painting

- .1 After inspection and before leaving the shop, clean all steel work as described in the appropriate AESS category section below.
- .2 Immediately after cleaning, apply a shop coat of primer to all steel work. Allow to dry in a dust free area.
- .3 Apply 1 additional shop coat of primer as specified to parts of shop coated steel surfaces that will be inaccessible after erection.
- .4 Clean surfaces within 50 mm of any field weld location of materials that would prevent proper welding or produce objectionable fumes while welding is being done.
- .5 After erection and immediately after grinding welds, etc. touch up primer with the specified products. Prepare steel in accordance with manufacturers' recommendations. Paint in accordance with 09 10 00.

.11 Galvanizing

- .1 Ensure that the galvanizing process leaves a smooth and uniform surface.
- .2 During galvanizing, use procedures to ensure that members do not deform excessively.

.12 Rusted Steel

- .1 Where indicated, treat exposed faces of the structural steel to obtain a rusty brown appearance
- .2 The appearance shall conform to the colour and texture of samples available for inspection at the office of the Consultant. In addition to these samples, colour photographs may be obtained on request from the Consultant.
- .3 Shot blast the exposed faces of the steel to be of rusty appearance to remove the major mill scale, but leaving about 10% of the mill scale on the surfaces.
- .4 In order to accelerate the rusting process, the following method is suggested:
 - .1 Spray surfaces with saltwater as many times as required after fabrication.
 - .2 Thoroughly wash down the salt before application of the final protective coating specified.
- .5 No erection markings are permitted on the exposed faces. Use tags for markings.
- .6 Take care to avoid soiling of the exposed faces with footprints, tire marks, oil patches, etc. which when wiped off may leave patches of a different colour on the exposed surfaces.
- .7 Provide suitable protection to all work adjacent to or below steel framing with rusty surfaces to prevent staining of other exposed construction. Make good any stained surfaces to the Consultant's approval.

.13 Architectural Review

- .1 The Architect shall review the AESS steel in place and determine acceptability based on the Category and visual samples (if applicable). The Fabricator/Erector will advise the consultant the schedule of the AESS work.

.14 Adjusting and cleaning

- .1 Provide suitable protection to all work adjacent to or below steel framing with rusty surfaces to prevent staining of other exposed construction. Make good any stained surfaces to the Consultant's approval.
- .2 Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780.

.15 Protection

- .1 Prevent staining of architecturally exposed steel by concrete, mortar, plaster, oils, paints or other foreign substances.
- .2 Do not use marking paint, crayons or other marking materials on exposed surfaces.

.16 Specific Requirements based on AESS Category

.1 AESS 1 Basic Elements

- .1 Rough surfaces are to be deburred and ground smooth. Sharp edges resulting from flame cutting, grinding and especially shearing are to be softened.
- .2 Intermittent welds are made continuous, either with additional welding, caulking or body filler. For corrosive environments, all joints should be seal welded.
- .3 Seams of hollow structural sections shall be acceptable as produced.
- .4 Standard structural bolts shall be used. Bolted connections shall be neatly arranged. All bolt heads in connections shall be on the same side, as specified, and consistent from one connection to another.
- .5 Weld spatter, slivers, surface discontinuities are to be removed. Weld projection up to 2 mm is acceptable for butt and plug welded joints. All exposed edges of plates shall be universal mill or guided flame cut. Exposed cut edges of beam flanges shall be guided flame cut. Cut surfaces shall be equal in smoothness to a mill finish.

.2 AESS 2 - Feature Elements (Viewed at a distance greater than 6 m)

- .1 Adopt the minimum requirements of AESS 1 and the following:
- .2 Provide visual samples of critical elements of structural steel identified as AESS 2. Visual samples are either a 3-D rendering, a physical sample, a first off inspection, a scaled mock-up or a full-scale mock-up.
- .3 Supply, fabricate and erect steel to tolerances one-half of those of standard structural steel as specified in CSA S16 (i.e. twice as stringent).
- .4 Fabrication marks are to be invisible in the completed building, either by removing or by locating markings on surfaces concealed from view in the finished building such as on top of the top flange of beams.
- .5 Welds are to appear uniform and smooth. Welds not initially meeting this criteria on completion are to be ground smooth.

.3 AESS 3 - Feature Elements (Viewed at a distance less than 6 m)

- .1 Adopt the minimum requirements of AESS 1 and AESS 2 and the following:

- .2 In addition to fabrication marks, all mill marks are not to be visible in the finished product.
 - .3 Butt and plug welds are to be ground smooth and filled. Caulking or body filler is acceptable.
 - .4 HSS Weld seams shall be oriented away from view unless otherwise noted.
 - .5 Cross sectional abutting surfaces are to be carefully aligned.
 - .6 Joint gaps shall be limited to a clear distance between abutting members of 3 mm.
 - .7 Unless otherwise noted all connections are to be welded.
 - .8 Where bolted connections are permitted, use tension control bolts. Rounded head shall be oriented to surface most apparent to view.
- .4 AECS 4 - Showcase Elements
- .1 Adopt the minimum requirements of AECS 1 through AECS 3 and the following:
 - .2 HSS seams shall be treated so they are not apparent. Where seams cannot be made invisible through orientation they shall be ground smooth
 - .3 Welded transitions between members are required to be contoured and blended.
 - .4 The steel surface imperfections should be filled and sanded.
 - .5 Where welds show through on a back face exposed to view, minimize the appearance of the show through by grinding.

END OF SECTION 05 12 00

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Provide all material and labour required for the completion of the Contract. Breakdown of Work by Section is for guidance only and is not necessarily complete.
- .2 Work Furnished and Installed:
 - .1 Steel roof and floor deck.
 - .2 Holes in deck for other trades.
 - .3 Hole and edge reinforcing welded to deck.
 - .4 Closures.
 - .5 Steel studs on composite steel beams.
- .3 Related Work Specified Elsewhere:
 - .1 Framing of openings in deck exceeding 450 mm in roof deck and 300 mm in floor deck and framing of edges of openings in metal deck where loss of bearing to metal deck occurs: Section 05 12 00
 - .2 Clip angles at columns to support metal deck: Section 05 12 00
 - .3 Steel bearing plates and related anchors to receive metal deck: Section 05 12 00
 - .4 Installation of sound absorbing element:
- .4 Work Furnished but not Installed:
 - .1 Sound absorbing element.

1.2 EMBODIED CARBON DOCUMENTATION REQUIREMENTS

- .1 Refer to the GWP (global warming potential) maximum limits on embodied carbon referenced in the General Notes within the structural Contract Documents.
 - .1 The GWP limits are expressed in kg CO₂e per metric tonne (1000 kg) of fabricated steel.
 - .2 The GWP limits represent stages A1-A3 in the life cycle analysis of the steel production process.
- .2 Metal deck is only to be sourced from suppliers that provide a Type III EPD (environmental product declaration) for their products. Industry average, Type II EPDs are not acceptable.

1.3 STANDARDS, CODES AND ACTS

- .1 Conform with the Ontario Building Code 2012 under Ontario Regulation 332/12, including Ontario Regulation 88/19 and any applicable acts of authority having jurisdiction and the following:
 - .1 CAN/CSA-S136, North American Specifications for the Design of Cold Formed Steel Structural Members (using the Appendix B provisions applicable to Canada)
 - .2 CAN/CSA-S16, Limit States Design of Steel Structures
 - .3 CSA Standard W47.1, Certification of Companies for Fusion Welding of Steel Structures, Canadian Standards Association.
 - .4 CSA Standard W59, Welded Steel Construction, Canadian Standards Association.

- .5 CSSBI 10M-96, Canadian Sheet Steel Building Institute (CSSBI) Standards for Steel Roof Deck - 1976 Revised 1981 and Steel Floor Deck - 1976 Revised 1981.
- .6 ASTM A108, Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality, American Society of Testing and Materials.
- .7 ASTM A653/A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, American Society of Testing and Materials.
- .2 Where there are differences between the specifications, drawings, codes, standards or acts, the most stringent shall govern.

1.4 QUALIFICATIONS

- .1 Any organization undertaking to weld under this Contract shall be certified by the Canadian Welding Bureau under the requirements of CSA Standard W47.1.
- .2 Welders engaged in this work shall furnish proof that they have successfully carried out welding of gauge metal.

1.5 DESIGN

- .1 Design deck in accordance with requirements of the Ontario Building Code to safely support loadings shown or implied.
- .2 Design deck such that the live load deflection of the deck shall not exceed 1/360 of the span for floor deck, nor 1/240 of the span for roof deck, except that when decks support a plastered ceiling or similar finish, the deflection due to live load shall not exceed 1/360 of the span.
- .3 Design deck anchorage to the supporting framework or walls to safely resist net uplift forces shown, but not less than 0.50 kPa.
- .4 Design deck anchorage to the supporting framework or walls to safely resist all diaphragm forces indicated on the drawings and diaphragm shear force diagrams, but not less than 2.3 kN/m.
- .5 Wherever possible, design units to span over three or more supports in order to obtain increased rigidity.
- .6 Determine structural properties of the structural concrete slab and composite construction in accordance with requirements of the Ontario Building Code.
- .7 Design composite deck to safely support the weight of the concrete and reinforcing steel and other construction loads before the composite action of the deck system takes place, without excessive deflection and without exceeding allowable working stresses and without shoring of deck.
- .8 If required, design and detail temporary intermediate support of the composite deck so that allowable working stresses are not exceeded before composite action takes place
- .9 Where shown, design headed studs to purlins to act compositely with deck system so as to limit purlin deflection under live load to L/360

- .10 Where headed studs to purlins and beams to act compositely with concrete/deck system have been indicated, these have been based on cellular steel deck where the flute average width is at least twice the height of the deck. Where 2 studs are required per flute perpendicular to the beam, design value is 72% of that for a single stud. If 3 studs per flute, design value is 60% of a single stud. In any event, do not tender on less than shown on the structural drawings.
- .11 Do not assume composite action between girders and concrete/deck system.
- .12 Design and connect metal edge and closure strips to safely resist construction loads and prevent the loss of grout when the deck is concreted.
- .13 Design and install deck units to safely sustain uplift forces due to wind during erection until the concrete slabs are placed.
- .14 Design and connect metal screeds forming vertical sides of the concrete slabs placed on the metal deck to obtain concrete edges with an accuracy of 6 mm based on a concrete slump of 75 mm and the use of mechanical vibrators.
- .15 Design framing for openings or holes through the roof deck up to 450 mm maximum width and in floor deck up to 300 mm maximum width measured perpendicular to the span of the deck.

1.6 SUBMITTALS

- .1 Environmental Product Declaration (EPD) Submittal.
 - .1 Submit Type III EPDs for metal deck procured for the project.
- .2 Shop Drawings
 - .1 Submit erection and fabrication drawings for review by the Consultant.
 - .2 Each drawing submitted shall bear the signature and stamp of a qualified Professional Engineer licensed in the Province of Ontario.
 - .3 Amongst other items, show the following:
 - .1 Types of deck and their locations
 - .2 Design loads
 - .3 Net uplift pressures
 - .4 Openings and their reinforcement
 - .5 Gauge of steel deck
 - .6 Surface protective coating
 - .7 Flashings and closure plates
 - .8 Welding and/or mechanical connector details
 - .9 Sufficient detail sections showing the deck's orientation to support members to facilitate erection of deck
 - .10 Locations, size, number, type and welding requirements of welded stud shear connectors.
 - .4 Do not reproduce the structural drawings to serve as shop drawings without the consent of the Consultant.
 - .5 Furnish the inspection company with a copy of each shop drawing bearing the Consultant's reviewed stamp.

.3 Mill Test Reports

- .1 Submit two copies of mill test reports properly correlated to the materials.

.4 As-Built Drawings

- .1 Mark on 1 complete sets of final drawings any changes, additions or deletions that occur during the construction as a result of the Contractor's work, change orders or for any other reason.

PART 2 – PRODUCTS

2.1 MATERIALS

.1 Metal Deck

- .1 To CSSBI 10M. Minimum steel core thickness 0.76 mm except that deck exposed to view in Public areas within the finished building shall have a minimum steel core thickness of 0.91 mm.

.1 Public areas are defined as areas that are accessible to building users, excluding closets, storage, janitor, mechanical spaces and other similar service areas.

- .2 Conform to the requirements of CSA S136.21 A3 Material Clause with minimum Grade of 40 Ksi (275 Mpa).

- .3 Form deck with integral ribs of a shape acceptable to the Consultant.

- .4 Provide a minimum width of rib contact with the supporting steel work of 40 times the thickness of the deck.

- .5 Provide sections with interlocking type side joints.

- .6 Supply composite deck floor units with suitable lugs or deformations to provide composite action with the concrete fill.

.2 Acoustic Metal Deck

- .1 Provide Acoustic Metal Deck where indicated on the drawings.

- .2 Form acoustic metal deck with 3 mm diameter holes on 9 mm staggered centres in a continuous band on all vertical ribs.

- .3 Acoustic metal deck shall have a NRC value of 0.65 or better obtain in accordance with ASTM C-423.

.3 Sound absorbing Element

- .1 Glass fibre insulation, density of 17.6 kg/m³, profiled to completely fill the flutes in the top of the acoustic deck.

.4 Miscellaneous Metal

- .1 Metal cover plates, cell closures, web stiffeners, edge strips and flashings shall conform to material and finish as specified for deck and have a minimum steel core nominal thickness of 1.22 mm.

PART 3– EXECUTION

3.1 Protection:

- .1 Galvanizing in accordance with ASTM A653/A653M-06a.
 - .1 Interior exposure:
 - .1 Concealed from view: ZF75 galvalumeal wipe coat.
 - .2 Exposed to view and scheduled to receive a field-applied paint system: ZF75 galvalumeal wipe coat.
 - .3 Exposed to view and scheduled to remain unfinished: Z275 galvanized.
 - .2 Exterior exposure:
 - .1 Concealed or exposed to view: Z275 galvanized
 - .3 Touch up abrasions and welds with a brush coat of zinc rich primer.
 - .1 Touch up connector penetrations in galvanized OWSJ and beams with a field-applied coating of cold galvanizing compound per 05 12 00.

3.2 INSTALLATION

- .1 General
 - .1 Ensure that construction loads caused by the erection of the deck will not load structural members in excess of their design loads.
 - .2 Erect deck such that it is free of dirt, scale, foreign matter, dents or deformations.
 - .3 Adjust deck units to their final position before securing to supporting members. Supply and install steel packing between supporting members and deck to provide a minimum of 50 mm bearing. Permanently secure packing.
 - .4 Lap ends of non-composite deck units a minimum of 50 mm and only over supporting members.
 - .5 Where steel deck spans parallel to beams that are to have studs added to top flange, arrange flutes to be centred over beams. If this is not possible, have decking interrupted so that studs can be properly placed on beams to allow composite action to take place.
 - .6 When deck units are adjusted to their final position, anchor to supports and to members parallel to the deck span to safely resist uplift forces and lateral forces, but with not less than 19 mm diameter fusion welds at a maximum spacing of 400 o.c. or every second flute, whichever is less. Where deck will be exposed to weather without cover, or where welding of deck is impracticable, secure deck with a minimum #12 self tapping screws at an average spacing of 300 o.c.
 - .7 Provide a minimum of 50 mm of end bearing on supports. Fasten side joints of deck units between supports by clinching at 600 mm intervals or with 25 mm long welds at 1000 mm intervals. Secure structural flashings and the like to deck with sheet metal screws or welding.
 - .8 Make fusion welds of deck to supporting members well within bearing width of supporting members.
 - .9 Weld gauge metal to obtain satisfactory fusion between the deck and supports without damage to the deck or its supports.

- .10 Provide minimum closure channels along edges of all deck parallel to span where deck is not otherwise supported.
- .2 Holes Through Deck
 - .1 Cut openings and reinforce edges as required for pipes, ducts, hoppers and the like. Indicate openings as reinforcement for openings on fabrication and erection drawings. The maximum size of an unreinforced opening is 150 mm square or in diameter. Reinforce openings having a dimension over 150 mm, but not exceeding 450 mm as required. Framing for openings with a dimension exceeding 450 mm in roof deck and 300 mm in floor deck is specified under Structural Steel Section 05 12 00 . The location of holes through decking shall be to the approval of the Consultant.
 - .2 Obtain actual opening and holing information before proceeding with the work. Cooperate with other trades as necessary.

END OF SECTION 05 31 00

1 General

1.1 SECTION INCLUDES

- .1 Labour, Products, equipment and services necessary for rough carpentry Work in accordance with the Contract Documents.

1.2 REFERENCES

- .1 ASTM A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- .2 ASTM A325, Specification for Bolts Quenched/Tempered Steel Nominal Thread Diameter M16 - M36 For Structural Steel Joints.
- .3 ASTM A653, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .4 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .5 ASTM F1667, Driven Fasteners: Nails, Spikes and Staples.
- .6 CAN/CSA O80 Series M, Wood Preservation.
- .7 CSA O121-M, Douglas Fir Plywood.
- .8 CAN/CSA O141, Softwood Lumber.
- .9 CAN/ULC-S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .10 NLGA, Standard Grading Rules for Canadian Lumber, National Lumber Grades Authority.

1.3 QUALITY ASSURANCE

- .1 Lumber identification: Grade stamp of an agency certified by the Canadian Lumber Standards Accreditation Board.
- .2 Plywood identification: Grade mark in accordance with applicable CSA standards.
- .3 Lumber quality: Carefully select individual pieces so that knots and obvious defects will not interfere with placing bolts, proper nailing or making proper connections.
- .4 Moisture Content of wood at time of construction shall be 19% maximum.
- .5 Each piece of pressure treated lumber and fire retardant treated lumber shall be shop marked with the pressure treatment brand and ULC monogram respectively, in accordance with CAN/CSA O80-M.
- .6 Dimensions of lumber shall conform to dressed sizes specified in CAN/CSA-0141 unless actual dimensions are otherwise indicated or specified.
- .7 Dimensional references to lumber on Drawings and in Specifications are to nominal sizes unless actual dimensions are indicated. Such actual dimensions shall be dry size.
- .8 Lumber defects: Discard wood with defects which will render a piece unable to serve

its intended function. Lumber will be rejected by Consultant for excessive warp, twist, bow, crook, mildew, fungus, or mould, as well as for improper cutting and fitting, whether or not it has been installed.

1.4 **ENVIRONMENTAL REQUIREMENTS**

- .1 When it is required that wood maintain dimensional stability and tolerances to ensure accurate installation of later work, store and install it only in dry areas, and where no further installation of moist materials is contemplated.
- .2 Separate and recycle waste materials, including packaging materials, in accordance with Section 01 74 21 "Construction Waste Management and Disposal".

1.5 **PRODUCT DELIVERY, STORAGE AND HANDLING**

- .1 Store materials in a dry area. Cover materials with tarpaulins or polyethylene sheets to prevent moisture absorption and impairment of structural and aesthetic properties. Vent to allow air movement. Tie covering to keep in place.

2 Products

2.1 **MATERIALS**

- .1 General: All materials under Work of this Section, including but not limited to, adhesives are to have low VOC content limits.
- .2 Lumber: Softwood, G4S, moisture content 19% or less at time of installation, in accordance with the following:
 - .1 Lumber shall be of same species and grade, equally seasoned and shall be processed and stamped at same mill. .
 - .2 CSA O141 and NLGA Standard Grading Rules for Canadian Lumber.
 - .3 Board quality: Construction or better.
 - .4 Glued end-jointed (finger-jointed) lumber is not acceptable.
 - .5 Furring, blocking, nailing strips, grounds, rough bucks, cants, curbs, fascia backing and sleepers:
 - .1 S4S.
 - .2 Board sizes: "Standard" or better grade.
 - .3 Dimension sizes: "Standard" light framing or better grade.
 - .4 Post and timbers sizes: "Standard" or better grade.
 - .5 Grade No.2 or better, exterior wood pressure preservative treated
 - .6 Dimension quality:
 - .1 Structural joists, planks, and framing: No. 1 Select Structural.
 - .2 Light framing: Construction

- .3 Panel Materials:
 - .1 Douglas fir plywood (DFP): to CSA-O121, standard construction.
 - .2 Canadian softwood plywood (CSP): to CSA-O151, standard construction.
 - .3 Sheathing grade, telephone and electrical panels CSA-0153 19mm thick S1S, (FRT).
- .4 Wood Preservative
 - .1 Pressure impregnate with alkaline copper quaternary (ACQ) to CSA-O80 Series, maximum allowable VOC limit 350 g/L.
- .5 Plywood:
 - .1 Plywood (WD-3): Pressure treated plywood, thickness as indicated on drawings, with pressure treatment as specified in this Section.
- .6 Surface applied wood preservative: Green coloured copper naphthenate or 5% pentachlorophenol solution, water repellant preservative or same copper based preservative as used for shop impregnation, in accordance with CAN/CSA O80.
- .7 Rough hardware: Conforming to ASTM F1667; Nails, bolts, screws, anchors, expansion shields, and other fastenings required to frame and fix rough carpentry as follows: .
 - .1 Nails, spikes and staples: Spiral type.
 - .2 Bolts: ASTM A325; 12.7 mm diameter minimum with nuts and washers unless noted otherwise.
 - .3 Screws: Countersunk head, full thread type.
 - .4 Proprietary fasteners: Toggle bolts, expansion shields, lag bolts, screws, inorganic fibre plugs, recommended for purpose by manufacturer.
 - .5 Galvanize rough hardware used in fire treated wood and hardware exposed to the atmosphere.
- .8 Fire Retardant Treatment (FRT)
 - .1 Pressure impregnation fire retardant treatment (FRT): Wood and plywood where necessary to comply with OBC fire performance requirements, to the satisfaction of the authorities having jurisdiction.
 - .2 Vacuum pressure impregnate wood with fire retardant treatment in accordance with CAN/CSA- O80, C20 for lumber and C27 for plywood.
 - .3 Provide flame spread rating of 25 or less. Provide ULC or WHI label for treated lumber and plywood as received from the pressure treatment plant. Include identification colour dye in fire retardant chemicals for wood which is concealed in the final work.
 - .4 Pressure treat materials before final milling and kiln-dry after treatment to the specified moisture content.

- .5 Do not expose pressure-treated materials to dampness between time of treatment and time finish is applied. Remove surface salt deposits before finishing.
- .6 Fire retardant treatment of lumber and plywood (interior and protected locations): 'Dricon FRT' fire retardant treatment by Biewer Lumber or approved alternative, conforming to ASTM E84, to provide a flame spread rating of 25 or less.
- .9 Accessories
 - .1 General purpose adhesive: to CSA-O112.
 - .2 Nails, spikes and staples: to CSA-B111.
 - .3 Bolts: 12.5 mm diameter unless indicated otherwise, complete with nuts and washers.
 - .4 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fiber plugs, explosive actuated fastening devices, recommended for the purpose by the manufacturer.
 - .5 Fasteners for use in pressure treated wood: Provide hot dipped galvanized fasteners complying to ASTM A153 and connectors in accordance with ASTM A653, Class G185 for non-structural members. Provide type 304 or 316 stainless steel fasteners and connectors for use in Structural, pressure treated wood.
- 3 Execution**
 - 3.1 EXAMINATION**
 - .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.
 - 3.2 GENERAL**
 - .1 Lay out work carefully and to accommodate work of others. Cut and fit accurately: erect in position indicated by Drawings.
 - .2 Install rough carpentry to allow for expansion and contraction of the materials.
 - .3 Cut work into lengths as long as practicable and with square ends. Align, level, square, plumb, and secure work permanently in place. Brace work temporarily as required. Join work only over solid backing.
 - .4 Bore holes true to line and to same size as bolts. Drive bolts into place for snug fit, and use plates or washers for bolthead and nut bearings. Turn up bolts and lag screws tightly when installed, and again just before concealed by other work or at completion of Work.
 - .5 Provide anchors, bolts, and inserts required for attachment of the work of this Section, to those performing the work of other Sections and who are responsible for

their installation.

- .6 Do not attach work by wood plugs or blocking in concrete or masonry. Use lead shields, expansion shields, or similar methods only as approved by Consultant.

3.3 **FURRING AND BLOCKING**

- .1 Install furring and blocking, as required, to space-out and support windows, facings, fascia, soffit, siding and other work as required.
- .2 Provide wood blocking and shims as required at gaps between overhead steel supports and supported items below.
- .3 Coordinate with the applicable other trades and provide wood and/or plywood back-up within the metal stud framing as required to provide proper support for wall-mounted items, including but not necessarily limited to:
 - .1 Wall-mounted casework.
 - .2 Corner guards
- .4 Align and plumb faces of furring and blocking to tolerance of 1:600.
- .5 Coordinate with the applicable other sections and provide plywood panels to be built into other work for support of windows and other items as indicated.

3.4 **MISCELLANEOUS WOODWORK**

- .1 Fit and install wood furring, strapping, grounds and blocking. Adequately size, correctly place and conceal members for finishes, fitments and for Work under other Sections. Do not assume that Drawings show required work exactly or completely. Anchor wood members securely in place.
- .2 Install rough bucks, nailing strips and linings to rough openings as required for backing for frames and other Work.
- .3 Except where steel supports are specifically shown, provide wood blocking and supports in metal stud partitions for fastening of item such as casework and other wall mounted accessories. Have respective trades approve the location of such wood blocking.
- .4 Bolt wood blocking or nailing strips to steel framing.
- .5 Align and plumb faces of furring and blocking to tolerance of 1:600.
- .6 Use fire retardant lumber for blocking/framing in ceiling\spaces, partitions and bulkheads.
- .7 Miscellaneous blocking: Provide miscellaneous wood blocking in wall cavities for securing millwork and Smart Boards, Washroom accessories, partitions, baby and adult change tables, drinking fountains, basketball hoop framing, washroom partitions and screens, flat screen televisions, wall hung sinks and toilets and any additional areas as indicated and required.
- .8 At all hollow metal frames, install wood blocking at header and jambs to ensure rigid

installation and to prevent doors and frames from rattling.

3.5 WALL SHEATHING

- .1 Provide plywood wall sheathing for interior wall assemblies as required and indicated on Contract Drawings.
- .2 Apply lumber wall sheathing so that all ends are supported with end joints staggered.
- .3 Apply panel-type sheathing board so that vertical joints are staggered if the sheathing is applied horizontally and a gap of not less than 1.5 mm left between sheets of plywood.

3.6 BACKBOARDS

- .1 Install plywood backboards, primed and painted white on both sides, with fire retardant paint.
- .2 Use minimum 19 mm thick plywood on 19 x 38 mm furring around perimeter and at maximum 300 mm intermediate spacing.

3.7 NAILING STRIPS, GROUNDS AND ROUGH BUCKS

- .1 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.

3.8 FASTENERS

- .1 Frame, anchor, fasten, tie and brace members for required strength and rigidity.
- .2 Use hot dipped galvanized fasteners for exterior Work and Work below grade.
- .3 Countersink bolts and bolt heads as required for clearance of other Work.
- .4 Size fasteners to penetrate base member by half of fastener length minimum. Minimize splitting of wood members by staggering nails in direction of grain.
- .5 For plywood use spiral, annular or resin coated nails and staples.

3.9 SURFACE-APPLIED WOOD PRESERVATIVE

- .1 Treat raw surfaces, drilled holes and cut ends of pressure treated wood with 2 coats of wood preservative immediately after cutting.
- .2 Treat surfaces of pressure impregnated material (PT and FRT) which are exposed by cutting, trimming or boring, with wood preservative or fire retardant chemical, as applicable, before installation.
- .3 Apply preservative by dipping, by brush or by pouring into plugged holes to completely saturate surface for minimum 3 minute soak on lumber and one minute soak on plywood.
- .4 Apply fire retardant chemical to the requirements of the labelling authority and the authorities having jurisdiction.

3.10 EQUIPMENT BACKBOARDS

- .1 Provide backboards, 2400 mm high, throughout all communications rooms for mounting owner's equipment. Electrical room for panel installation coordinate with electrical equipment layouts. Use 19 mm thick G1S FRT plywood on 19 x 38 mm furring around perimeter and at maximum 400 mm intermediate spacing. Prepare for paint finish by Section 09 91 00. Coordinate mounting height with the Owner.

END OF SECTION

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Work Furnished and Installed:
 - .1 Wood decking.
 - .2 Ledgers and nailers.
- .2 Related Work Specified Elsewhere:
 - .1 Structural Steel, Section 05 12 00
 - .2 Glue-laminated Structural Units, Section 06 18 00
 - .3 Staining and finishing, Section 09 90 00

1.2 STANDARDS, CODES AND ACTS

- .1 Conform with the Ontario Building Code 2012 under Ontario Regulation 332/12, including Ontario Regulation 88/19 and any applicable acts of any authority having jurisdiction, and the following:
 - .1 CSA Standard O86-09, Engineering Design in Wood, Canadian Standards Association.
 - .2 CAN/CSA-O141-05, Softwood Lumber, Canadian Standards Association.
 - .3 CSA- B111-1974 (R2003), Wire Nails, Spikes and Staples, Canadian Standards Association.
 - .4 NLGA Standard Grading Rules For Canadian Lumber, 2005, National Lumber Grades Authority
 - .5 ASTM-A307-10 Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength, ASTM International.

1.3 SOURCE QUALITY CONTROL

- .1 Lumber identification: by grade stamp of a certified agency in accordance with the provisions of CAN/CSA-O141.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Handle, transport and store the materials by methods devised or approved by fabricator to prevent staining, soiling and damage.
- .2 Store materials to clear ground or other bearing surfaces, to prevent overstress, warp, twist, accumulation of water and snow, and to afford free movement of air on all sides of each unit.
- .3 Deliver materials to those who are responsible for installation, to the place they direct, and to meet installation schedule.
- .4 Wrap wood units with water resistant covering to ensure protection of finished surfaces from soiling during handling, shipping and storage.

PART 2 – PRODUCTS

2.1 MATERIALS

- .1 Wood decking:
 - .1 Conform to NLGA Standard Grading Rules for Canadian Lumber.
 - .2 Commercial grade, Spruce-Pine-Fir.
 - .3 127 x 38, single tongue and groove and "Veed" one side. One width shall be used throughout the project.
 - .4 133 x 89, double tongue and groove and "Veed" one side.
 - .5 Kiln dried to 15% average moisture content with a maximum moisture content of 19%.
 - .6 Decking lengths:
 - .1 As required by the spans and installation indicated, and
 - .2 A minimum of 90% of planks to be 3.0m and longer, with 50% of planks 4.85m and longer.
 - .7 Ends to be trimmed square.
- .2 Fasteners
 - .1 Nails: Conform to CSA-B111, Table 22, galvanized finish; sizes as recommended in CAN/CSA 086.
 - .2 Bolts, nuts and washers: ASTM A307, galvanized or stainless steel.
 - .3 Wood Screws: Conform to CSA O86, Clause 10.11

PART 3 – EXECUTION

3.1 INSTALLATION

- .1 Install decking in accordance with CAN/CSA O86.
- .2 Install decking as controlled random pattern continuous over two spans as defined in CAN/CSA-O86, Table 5.5.11.4, and, for controlled random, the following:
 - .1 Provide minimum of one bearing support for each plank.
 - .2 Minimize joints in middle third of any span.
- .3 Install sloping deck with tongues up.
- .4 Nail deck planks that are 64 or 89 mm in thickness together with 8 in. deck spikes at 760 mm on centres in predrilled holes.
- .5 Fasten deck to supporting timber as per CAN/CSA-O86, Clause 5.5.11.2.1.
- .6 Bolt deck to the supporting steel members as indicated on the drawings.
- .7 Protect installed wood decking from moisture until final waterproofing is complete, paying particular attention to moisture content of decking that is to be covered with a membrane, insulation, flooring and the like which may prohibit proper drying of the wood.

.8 Protection and Treatment of Exposed Surfaces

- .1 Protect installed wood deck from staining or other damage until the final waterproofing system is in place.
- .2 Replace or refinish to the Consultant's approval any damaged or defective work, to ensure that no discernible variation in appearance results.
- .3 Remove tool marks, bruises and scratches.

END OF SECTION 06 15 00

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Provide all material and labour required for the completion of the Contract. Breakdown of Work by Section is for guidance only and is not necessarily complete.
- .2 Where steel members connect to wood members, the glued laminated sub-contractor shall cooperate with the steel sub-contractor.
- .3 Work Furnished and Installed:
 - .1 Glue-laminated structural units.
 - .2 Holes for other trades
- .4 Related Work Specified Elsewhere:
 - .1 Structural Steel, Section 05 12 00
 - .2 Protection of steel saddles, plates, brackets and the like forming part of wood connections, Section 05 12 00
 - .3 Wood decking, Section 06 15 00
 - .4 Staining and finishing, Section 09 96 00

1.2 STANDARDS, CODES AND ACTS

- .1 Conform with the Ontario Building Code 2012 under Ontario Regulation 332.12, including Ontario Regulation 88/19 and any applicable acts of any authority having jurisdiction, and the following (latest edition including any and all supplements):
 - .1 CAN/CSA-G40.21, Structural Quality Steel, Canadian Standards Association.
 - .2 CSA G164, Hot Dip Galvanizing of Irregularly Shaped Articles, Canadian Standards Association.
 - .3 CAN/CSA Standard O86, Engineering Design in Wood, Canadian Standards Association.
 - .4 CSA O112.10, Evaluation of Adhesives for Structural Wood products (Limited Moisture Exposure), Canadian Standards Association.
 - .5 CAN/CSA-O122, Structural Glued-Laminated Timber, Canadian Standards Association.
 - .6 CAN/CSA-O177, Qualification Code for Manufacturers of Structural Glued-Laminated Timber Canadian Standards Association.
 - .7 A307 Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
- .2 Where there are differences between the specifications, drawings, standards, codes or acts, the most stringent shall govern.

1.3 QUALIFICATIONS OF MANUFACTURER

- .1 Manufacture structural glue-laminated members in plant certified by Administrative Board Structural Glue-Laminated Timber Division, to CAN/CSA O177 to manufacture Class 1 (interior) members and Class X (exterior) members
- .2 At completion of project submit certificate in accordance with CAN/CSA O177, Appendix B.
- .3 Fabricator for welded steel connections to be certified in accordance with CSA Standard W47.1.

1.4 DESIGN

- .1 Connections are to be designed by a Professional Engineer registered in the province of Ontario, in accordance with CSA Standard O86 and CSA S16.

1.5 SUBMITTALS

- .1 Shop Drawings
 - .1 Submit shop drawings in accordance with Section 01 30 00.
 - .2 Shop drawings are to be submitted in PDF format or equivalent.
 - .3 Clearly indicate stress grade, service grade, appearance grade, shop applied finishes, and shop and erection details, including cuts, \holes, fastenings and connection hardware and camber.
 - .4 If requested by the Consultant, submit connection design calculations, stamped by the Engineer responsible for the design.
 - .5 Each shop drawing submitted shall bear stamp of a qualified Professional Engineer registered in the Province of Ontario.
- .2 Calculations
 - .1 Submit sketches and calculations bearing the stamp and signature of a Professional Engineer licensed in the Province of Ontario as may be necessary to show design and loading assumptions including, but not limited to, all connection designs and details including hardware, appearance and member net section design.
- .3 Certificates
 - .1 Submit manufacturer's certification for glulam in accordance with CSA O177.

1.6 DELIVERY AND HANDLING

- .1 Arrange delivery of members and/or panels in accordance with construction schedule to designated delivery location.
- .2 Individually wrap commercial, quality or architectural appearance grade members prior to leaving plant with a moisture resistant wrapping.
- .3 Use padded, non-marring slings for handling members.
- .4 Protect corners with wood blocking.
- .5 Slit underside of membrane covering during storage at site.
- .6 Store glued-laminated timber well blocked off ground and separated with stripping, so air may circulate around all four sides of members.

- .7 Cover top and sides with opaque moisture resistant membrane if unprotected.

1.7 PROTECTION

- .1 Maintain protection of glue laminated members until protected by building membrane/finishes, etc.
- .2 Glue laminated members are to be stored off-site in conditioned space to maintain average manufacturing Moisture Content (MC) of 12% +/-3%. Deliver to site for same day erection when possible. Inform consultant if members are to be stored on site, or if members exceed 15% average MC prior to erection.
 - .1 Members with a depth greater than 400mm exceeding 15% average MC are not to be erected until placement is confirmed with the consultant.
 - .2 Members exceeding 19% average MC are not to be erected until dried to the consultant's approval.
 - .3 Members with surface moisture content greater than 25% are not to be erected until dried to the consultant's approval.
 - .4 Average MC refers to the average moisture content over the depth and width of a member
- .3 Protect members from wetting once erected, refer to the Mass Timber Temporary Moisture Protection Plan, Section 01 33 30.
 - .1 Inform the consultant of any members exceeding 15% average MC and await instruction prior to enclosing/finishing.
 - .2 Members exceeding 19% average MC are not to be enclosed by any finishes until dried to the consultant's approval.
 - .3 Members with surface moisture content greater than 25% are not to be enclosed until dried to the consultant's approval.
 - .4 Average MC refers to the average moisture content over the depth and width of a member
- .4 Bolts, nuts, washers, timber rivets, split rings, shear plates and all other connectors are to be hot-dip galvanized where the connection and or connected member are exposed to view in the finished building.
- .5 Where exposed to view in the finished building, steel saddles, plates, brackets etc. forming parts of wood connections are to be prepared and painted in accordance with CICS/CPMA 1-73a.
- .6 Where concealed from view in the finished building steel saddles, plates, brackets etc. forming parts of wood connections are to be prepared and painted in accordance with CICS/CPMA 1-73a.
- .7 All steel materials outside the building envelope are to be galvanized in accordance with section 05 12 00 and as noted on the drawings.
- .8 Coat ends of all glue laminated lumber with two coats of clear sealer. For preservative treated lumber allow an appropriate curing/drying time prior to application of sealer.

PART 2 – PRODUCTS

2.1 SUGGESTED SUB-TRADE CONTACT INFORMATION – Glue laminated members

- .1 IWS Wood Products Inc., Ian Whittington, 705-377-5184
- .2 Nordic Engineered Wood, Tony Saad, 416.270.9663
- .3 Structurlam Products Ltd., Ron McDougall, 250.492.8912
- .4 Timber Systems Limited, Chris Williams, 905.294.7091
- .5 Timmerman Timberworks, Michael Krans 705.721.8916
- .6 Spring Valley Architectural Innovations, 289.684.8973
- .7 Goodfellow/Bryte Designs, Anwar Seif, 416.638.1932

2.2 GLULAM SUPPLY/FABRICATION

- .1 The glulam supplier/fabricator carried by the General Contractor shall be named in the bid submission and shall not be changed following award of contract unless approved by the Consultant on behalf of the Owner.

2.3 MATERIALS

- .1 Glue-Laminated Members:
 - .1 Glue-laminated member laminating stock. Conform to the following, unless otherwise noted on the structural drawings: Sustainably harvested Lodgepole Pine and/or Eastern white spruce to CAN/CSA O122. Refer to section 3 for stress grade, appearance grade etc.
 - .2 Adhesive: to CAN/CSA O122, Clause 5.3 as per service grade requirement. Use only phenol-based adhesive. The use of urea-based adhesive will not be permitted.
 - .3 Adhesive: Jowat 686.60 polyurethane resin (white) adhesive or equivalent to meet the requirements of CSA Standard O177-06 "Qualification code for manufacturers of structural glued-laminated timber"
- .2 Steel for connections: to CSA Standard G40.21M Grade 300W.
- .3 Bolts, nuts and washers: ASTM A307, galvanized.
- .4 Galvanizing: to CAN/CSA G164 hot dipped, minimum zinc coating of 600 g/m².
- .5 Sealer for exterior glued-laminated members: two coats of Sansin SDF plus one coat of Sansin SDF Top-coat as distributed by The Sansin Corporation, Strathroy, Ontario, or equivalent.
- .6 Sealer for untreated glued-laminated members: penetrating type, clear, non-yellowing liquid which will protect wood against moisture entry. Acceptable products: Sansin Wood Sealer as distributed by The Sansin Corporation, Strathroy, Ontario, Toll-Free: 1-877-SANSIN-1 (726-7461) or Olympic Premium Semi-transparent Stain. Product code 59594 or 51760 (clear)]

2.4 ALTERNATE GRADES

- .1 If the contractor wishes to provide an alternate grade of material, a complete proposal, including calculations and certified material specifications shall be provided to the Consultant for review.

- .2 The cost of reviewing any proposed alternate and coordinating such substitutions in order to make any resulting changes to the design will be billed directly to the Contractor on an hourly basis.

PART 3 – EXECUTION

3.1 FABRICATION

- .1 Glue-laminated Members: Fabricate glued laminated members in accordance with CSA O122 and to the following classifications:
 - .1 Stress grade. Conform to the following, unless otherwise noted on the structural drawings:
 - .1 Bending members where significant hogging moments are anticipated, i.e. tension in the top fibres: 20f-EX
 - .2 Bending members where significant hogging moments are not anticipated i.e. limited tension in the top fibres: 20f-E
 - .3 Columns except as noted above: 16c-E
 - .4 Tension members: 18t-E
 - .2 Appearance grade. Conform to the following, unless otherwise noted on the structural drawings:
 - .1 Members exposed to view in the finished building including all glulam framing in the Warm Up / Lounge area.
Commercial
 - .3 Service Grade: interior or exterior as indicated on the drawings.
 - .4 Mark laminated members for identification during erection so that marks will be concealed in final assembly.
- .2 Apply sealer to all sides and ends of members. As soon as possible after cutting apply sealer to cut ends of members.
- .3 Connections:
 - .1 Types of connections are shown.
 - .2 Connections are to be designed by a Professional Engineer registered in the Province of Ontario, in accordance with CSA Standard O86 and CSA S16.
 - .3 If requested by the Consultant, submit calculations, stamped by the Engineer responsible for the design.
- .4 Cut openings as required for pipes, ducts and the like in accordance with the following:
 - .1 Indicate openings on the fabrication and erections drawings
 - .2 Holes in glued-laminated beams:
 - .1 Provide holes as required up to a maximum diameter of 10% of the beam depth.
 - .2 Locate holes within the middle third of the span and within the middle third of the depth of the beam.
 - .3 Space adjacent holes at five times the largest diameter.

- .3 Do not overcut corners on square openings.
- .4 Holes not conforming to the above shall be approved by the Consultant prior to cutting.

3.2 ERECTION

- .1 Erect glued-laminated members level, plumb to correct positions indicated in accordance with CSA Standard O86.
- .2 Brace and anchor materials until permanently fixed.
- .3 Make adequate provisions for erection stresses.
- .4 Make splicing and jointing only in locations shown.
- .5 Fit members closely and accurately to other members and other assemblies.
- .6 Conform to erection tolerances specified in CAN/CSA-S16 Clause 29.3
- .7 Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.
- .8 Field cutting and alteration of members not permitted without Engineer's approval.
- .9 During construction, protect members, paying particular attention to columns and corners of walls, from damage.
- .10 Maintain wrapping on glulam members as long as possible and tarp floors to prevent staining from rain until building enclosure is complete.
- .11 Repair construction damage to timber members as required to maintain consistent appearance in the finished structure.
- .12 Avoid rapid changes in temperature and humidity when commissioning building HVAC systems to minimize checking of glue-laminated members. Gradually increase heat in the building. Do not direct any forced air heating systems onto glued laminated members.
- .13 Re-tightening Connections:
 - .1 Connection steel assemblies of the glued laminated members shall be inspected at 6 and 12 months after completion of the building envelope and commissioning of the HVAC systems, and tightened sufficiently to bring the faces of the connected materials into close contact without deformation.
 - .2 Any paint or other finishes damaged by these operations shall be made good.
 - .3 The cost of this work shall be included in the general contract tender price, but also identified as a separate price.

END OF SECTION 06 18 00

- 1 General
- 1.1 **SECTION INCLUDES**
 - .1 Labour, Products, equipment and services necessary for firestopping and smoke seals work in accordance with the Contract Documents.
- 1.2 **REFERENCES**
 - .1 ASTM C303, Standard Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation.
 - .2 ASTM C920, Standard Specification for Elastomeric Joint Sealants.
 - .3 ASTM C1104, Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
 - .4 ASTM E814, Test Method for Fire Tests of Through-Penetration Fire Stops.
 - .5 ASTM E2174, Standard Practice for On-Site Inspection of Installed Fire Stops.
 - .6 ASTM G21, Standard Test for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 - .7 CAN/CGSB 19.13, Sealing Compound, One Component, Elastomeric, Chemical Curing.
 - .8 CAN/ULC S102, Surface Burning Characteristics of Building Materials and Assemblies.
 - .9 CAN/ULC S114, Standard Method of Test for Determination of Non-Combustibility in Building Materials.
 - .10 CAN/ULC S115, Standard Method of Fire Tests of Firestop Systems.
 - .11 CAN/ULC S129, Standard Method Of Test For Smoulder Resistance Of Insulation (Basket Method).
 - .12 CAN/ULC S702, Thermal Insulation, Mineral Fibre for Buildings.
- 1.3 **DEFINITIONS**
 - .1 Fire Separation: A construction assembly, plane or device, either vertical or horizontal, which is required to prevent the passage of fire and smoke for a prescribed period of time. Proof of compliance to required time rating shall be by ULC, Warnock Hersey (or similar approved) certification or shall be as listed in the Ontario Building Code Supplementary Standard SB-2.
 - .2 Smoke Separation: A construction assembly, plane or device, either vertical or horizontal, which is not required to prevent the passage of fire for a prescribed period of time but is required to prevent the passage of smoke. A "Smoke Separation" is also known as a "Fire Separation with No Rating" or a "Zero Hour Rated Separation".
 - .3 Non-Rated Separation: A construction assembly, plane or device, either vertical or horizontal, which is not required to prevent the passage of fire for a prescribed period of time and is not required to prevent the passage of smoke.
- 1.4 **SYSTEM DESCRIPTION**

- .1 Firestopping and smoke seals: ULC or Intertek Testing Services listed Products and systems in accordance with CAN/ULC S115 suitable to actual application and installation conditions.
- .2 Firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar ULC or cUL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.
- .3 Firestop and smoke seal system shall achieve a fire resistance rating and smoke seal rating equal to that of assemblies into which they are installed.
- .4 Provide smoke sealants over firestopping materials or combination smoke seal/firestop seal material to form air tight barriers to retard the passage of gas and smoke.
- .5 Firestopping and smoke seals located at movement joints shall be designed with movement capability.
- .6 Provide penetration firestopping with mould and mildew resistance rating of 0 in accordance with ASTM G21.
- .7 Firestopping and smoke seals within mechanical and electrical assemblies shall be provided as part of the work of Divisions of mechanical, and electrical respectively.

1.5 SUBMITTALS

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate cUL or ULC reference standard, characteristics, limitations.
 - .2 Product transportation, storage, handling and installation requirements.
 - .3 Submit firestop and smoke seal manufacturer's Product data for materials and prefabricated devices, including manufacturer's printed installation instructions.
 - .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Fire rated and smoke sealed systems for each typical application.
 - .2 Construction details, accurately reflecting actual job conditions.
 - .3 ULC or Intertek Testing assembly listing.
 - .4 Each floor and wall assembly requiring firestop system with each corresponding ULC firestop system.
 - .3 Certification:
 - .1 Submit certified documentation from manufacturer for each worker performing work of this Section.

- .2 Submit installer's and Product manufacturer's certification verifying compliance with the Contract Documents and conformance with ASTM E814 and CAN/ULC S115.

1.6 QUALITY ASSURANCE

- .1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of firestopping and smoke seal work of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Manufacturer's direct representative and/or fire protection specialist shall be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures conforming to manufacturer's written recommendations published in their literature and drawing details.
- .3 Pre-construction meetings: Arrange with manufacturer's representative, Contractor, Consultant and Field Engineer to determine responsibility for handling such issues as FT rated partitions, firestop custom details, compatibility, mixed penetrations, and to review installation procedures 48 hours in advance of installation.

1.7 DELIVERY STORAGE AND HANDLING

- .1 Deliver materials to Place of Work in manufacturer's unopened containers, containing classification label with labels intact and legible at time of use.
- .2 Do not use damaged or adulterated materials exceeding their expiry date.

1.8 SITE CONDITIONS

- .1 Conform to manufacturer's requirements and maintain a minimum temperature of 5°C for a minimum period of 24 hour before application, during, and until application is fully cured.
- .2 Maintain sealant at a minimum 18°C for best workability.

2 Products

2.1 ACCEPTABLE MANUFACTURERS

- .1 Acceptable manufacturers of rated systems include:
 - .1 AD Fire Protection Systems Inc.
 - .2 Hilti Canada Corporation.
 - .3 3M Canada Inc.
 - .4 Tremco Ltd.

2.2 GENERAL SYSTEM REQUIREMENTS

- .1 All materials under work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
- .2 Do not use Products containing asbestos.
- .3 Firestopping components shall not contain volatile solvents or require special application to protect plastic pipe from firestopping compound.
- .4 Provide smoke seal sealant in following colours:

- .1 Grey or white in finished areas.
- .2 Red in unfinished areas.
- .5 Smoke sealant for overhead and vertical joints for floor to be self-levelling and non-sagging sealant.
- .6 Smoke sealant at vertical through penetrations in areas with floor drains shall be waterproof type.

2.3 MATERIALS

- .1 Following materials have been provided for convenience. Contractor shall provide complete system with all components and accessories as required for fire resistant and smoke seal installation.
- .2 Firestop sealant: single component, low modulus, silicone rubber, moisture curing sealant to ASTM C920, ULC labelled to CAN/ULC S115.
- .3 Pre-Installed firestop devices for use with non-combustible and combustible pipes, conduit and/or cable bundles penetrating concrete floors and walls.
 - .1 Cast-in place firestop device complete with aerator adaptor when used in conjunction with aerator system. Model CP 680-P by Hilti or approved alternative.
 - .2 Cast-in place firestop device for use with non-combustible penetrants. Model CP 680-M by Hilti or approved alternative.
 - .3 Speed sleeve for use with cable penetrations. Model CP 653 by Hilti or approved alternative.
 - .4 Firestop block. Model CFS-BL by Hilti or approved alternative.
- .4 Re-penetrable, round cable management devices for use with new or existing cable bundles penetrating walls:
 - .1 Speed sleeve with integrated smoke seal fabric membrane. Model CP 653 by Hilti or approved alternative.
 - .2 Firestop Sleeve. Model CFS-SL SK by Hilti or approved alternative.
 - .3 Retrofit sleeve for use with existing cable bundles. Model CFS-SL RK by Hilti or approved alternative.
 - .4 Gangplate for use with multiple cable management devices. Model CFS-SL GP by Hilti or approved alternative.
 - .5 Gangplate Cap for use at blank openings in gangplate for future penetrations. Model CFS-SL GP CAP by Hilti or approved alternative.
- .5 Firestop insulation: to CAN/ULC S702, Type 2; mineral fibre manufactured from rock or slag, suitable for manual application.
 - .1 Density: Minimum 64 kg/m³ when tested to ASTM C303.
 - .2 Combustibility: Noncombustible to CAN/ULC S114.
 - .3 Melt temperature: >1175 degrees C.
 - .4 Surface burning characteristics: to CAN/ULC S102, maximum flame spread of 0, smoke developed of 0.

- .5 Moisture Absorption: 0.04 percent when tested to ASTM C1104.
- .6 Smoulder Resistance: 0.01 percent when tested to CAN/ULC S129.
- .6 Damming, back-up, supports, and anchorage: In accordance with manufacturer's fire rated systems and to acceptance of authorities having jurisdiction.
- .7 Primer: As recommended by firestopping sealant manufacturer.
- 3 Execution
- 3.1 **EXAMINATION**
 - .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
 - .2 Verify that substrates and surfaces to receive firestopping and smoke seals are clean, dry, and frost free.
- 3.2 **PREPARATION**
 - .1 Prepare, modify, and adjust void sizes, proportions, and conditions to conform to fire rated and smoke sealed assembly requirements such as assembly opening size and dimensional restrictions.
 - .2 Clean surfaces to remove material detrimental to bond including dust, paint, rust, oil, grease, moisture, frost and other foreign matter to manufacturers recommendations.
 - .3 Mask adjacent surfaces to avoid spillage and over-coating of adjacent surfaces. Remove stains from adjacent surfaces.
- 3.3 **INSTALLATION**
 - .1 Install firestopping and smoke seal systems in accordance with reviewed Shop Drawings, manufacturer's instructions and fire rated assembly to establish continuity and integrity of fire separations.
 - .2 Install firestop insulation in compacted thicknesses required by ULC design. Compress insulation approximately 50 percent.
 - .3 Install primers as recommended by firestop and smoke seal Product manufacturers.
 - .4 Install temporary forming, damming, back-up as required, remove after materials have achieved initial cure and will resist displacement.
 - .5 Install firestop and smoke seal filler in horizontal joints providing 25% compression fit.
 - .6 Use resilient, elastomeric firestopping and smoke seal systems in following locations:
 - .1 Openings and sleeves for future use.
 - .2 Penetration systems subject to vibration or thermal movement.
 - .3 Penetration systems in acoustical containment enclosures.
 - .7 Trowel and tool exposed firestop and smoke seal. Product surfaces to uniform, smooth finish.
 - .8 Seal joints to ensure an air and water resistant seal capable of withstanding compressions and extensions due to thermal wind or seismic joint movement.
 - .9 Taped joints will not be acceptable.

- .10 Repair damaged firestopped and smoke sealed surfaces to acceptance of Consultant.
 - .11 Identify each firestop and smoke seal penetration assembly with permanent label listing following:
 - .1 Assembly and rating in hours.
 - .2 Date of installation.
 - .3 Installing company's name and telephone number.
 - .12 Do not cover materials until full cure has taken place.
- 3.4 **INSPECTION AND TESTING**
- .1 Inspection of through-penetration firestopping shall be performed in accordance with ASTM E2174 to ensure that firestopping and smoke seals have been installed in accordance with Contract documents and to tested and listed firestop system.
- 3.5 **CLEAN-UP**
- .1 Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.
 - .2 Remove excess materials and debris immediately after application.
- 3.6 **SCHEDULE OF FIRESTOP AND SMOKE SEAL LOCATIONS**
- .1 Following firestop and smoke seal location schedule is included for convenience and may not be complete. Examine Contract Drawings and other specification sections and determine entire extent of work of this Section. Generally provide systems with required fire and smoke ratings at following locations:
 - .1 Gaps at intersections of fire-resistance rated walls and partitions.
 - .2 Control and sway joints in fire-resistance rated walls and partitions.
 - .3 Gaps at top of fire-resistance rated partitions and walls.
 - .4 Penetrations through fire-resistance rated walls and partitions including mechanical and electrical services and openings and sleeves for future use.
 - .5 Penetrations through fire-resistance rated floor slabs, ceilings, and roofs.
 - .6 Gaps at edge of floor slabs at exterior walls.
 - .7 Perimeter of retaining angles on rigid ducts greater than 0.012 m², firestopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.
 - .8 Where indicated on drawings.
 - .9 At non-rated assemblies that require a smoke seal.
 - .10 Where required by Ontario Building Code.

END OF SECTION

1 General

1.1 DESCRIPTION

- .1 This section provide the elastomeric sealants and their implementation that are used to seal building joint assemblies.
- .2 Labour, Products, equipment and services necessary for sealant Work in accordance with the Contract Documents.
- .3 Work of this Section does not include sealants in firestopping and smoke sealed assemblies.
- .4 Work of this Section does not include sealant work identified in individual specification sections.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C 919-[08], Standard Practice for Use of Sealants in Acoustical Applications.
 - .2 ASTM C834, Specification for Latex Sealants.
 - .3 ASTM C920, Specification for Elastomeric Joint Sealants.
 - .4 ASTM C1330, Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants.
- .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 19-GP-5M-[1984], Sealing Compound, One Component, Acrylic Base, Solvent Curing (Issue of 1976 reaffirmed, incorporating Amendment No. 1).
 - .2 CAN/CGSB-19.13-[M87], Sealing Compound, One-component, Elastomeric, Chemical Curing.
 - .3 CGSB 19-GP-14M-[1984], Sealing Compound, One Component, Butyl-Polyisobutylene Polymer Base, Solvent Curing (Reaffirmation of April 1976).
 - .4 CAN/CGSB-19.17-[M90], One-Component Acrylic Emulsion Base Sealing Compound.
 - .5 CAN/CGSB-19.24-[M90], Multi-component, Chemical Curing Sealing Compound.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for joint sealants and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Product data: Submit copies of Product data in accordance with Section 01 33 00 describing type, composition and recommendations or directions for surface preparation, material preparation and material installation.
 - .3 Manufacturer's product to describe:

- .1 Caulking compound.
 - .2 Primers.
 - .3 Sealing compound, each type, including compatibility when different sealants are in contact with each other.
 - .2 Samples:
 - .1 Submit samples of each type of material and colour.
 - .2 Cured samples of exposed sealants for each colour where required to match adjacent material.
 - .3 Two samples of sealant/caulking, for colour selection. Two samples of back-up material and primer for physical characteristics.
 - .3 Manufacturers' Instructions
 - .1 Submit instructions to include installation instructions for each product used.
- 1.4 **DELIVERY, STORAGE AND HANDLING**
 - .1 Arrange delivery of materials in original, unopened packages with labels intact, including batch number, and ensure that on-site storage is kept to a minimum. Do not store materials on site where there exists any danger of damage from moisture, direct sunlight, freezing and other contaminants.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
 - .4 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect joint sealants from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- 1.5 **QUALITY ASSURANCE**
 - .1 Qualifications: Work of this Section shall be executed by trained applicators approved by sealant manufacturer and having a minimum of 5 years proven experience.
- 1.6 **EXTENDED WARRANTY**
 - .1 Submit an extended warranty for Sealant Work in accordance with General Conditions, except that warranty period is extended to 2 years from date of Substantial Performance of the Work.
 - .1 Warrant against leakage, cracking, crumbling, melting, shrinkage, running, loss of adhesion and staining adjacent surfaces.
 - .2 Coverage: Complete replacement including affected adjacent Work.
- 1.7 **SITE CONDITIONS**

- .1 Do not install materials when ambient air temperature is less than 5 degrees Celsius, when recesses are wet or damp, or to manufacturer's recommendations.
- .2 Ambient Conditions:
 - .1 Proceed with installation of joint sealants only when:
 - .1 Ambient and substrate temperature conditions are within limits permitted by joint sealant manufacturer or are above 4.4 degrees C.
 - .2 Joint substrates are dry.
 - .3 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.
 - .3 Joint-Width Conditions
 - .1 Proceed with installation of joint sealants only where joint widths are as allowed by joint sealant manufacturer for applications indicated.
 - .4 Joint-Substrate Conditions:
 - .1 Proceed with installation of joint sealants only after contaminants capable of interfering with adhesion are removed from joint substrates.
- 2 Products**
- 2.1 SEALANT MATERIALS**
 - .1 All materials under Work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
 - .2 Use materials as received from manufacturers, without additives or adulterations. Use one manufacturer's Product for each kind of Product specified.
 - .3 Do not use caulking that emits strong odours, contains toxic chemicals or is not certified as mould resistant in air handling units.
 - .4 When low toxicity caulks are not possible, confine usage to areas which off gas to exterior, are contained behind air barriers, or are applied several months before occupancy to maximize off gas time.
 - .5 Where sealants are qualified with primers use only these primers.
 - .6 Where exposed the colours shall match the substrate, as approved by the Owner.
- 2.2 Sealant Type A: ASTM C920, Type S, Grade NS, Class 25; One-part, non-sag type, silicone sealant, in standard colours selected.**
 - .1 'DC CWS' by Dow Corning Inc.
 - .2 'Sikasil 305CN' by Sika.
 - .3 'Tremsil 400' by Tremco.
- 2.3 Sealant Type B: ASTM C920, Type S, Grade NS; One-part mildew-resistant silicone, in standard colours selected.**
 - .1 '786 Mildew Resistant Silicone Sealant' by Dow Corning Inc.
 - .2 'Sikasil GP Mildew Resistant' by Sika.

- .3 'Tremsil 200 Silicone Sealant' by Tremco Ltd.
- 2.4 Sealant Type C: ASTM C834; Pure acrylic siliconized sealant; in standard white colour (paintable).
 - .1 '950A Siliconized Acrylic Latex Caulk' by Sherwin Williams.
 - .2 'Tremflex 834 Siliconized Sealant' by Tremco Ltd.
- 2.5 Sealant Type D: Urethanes one part: Non-sag: to CAN/CGSB-19.13, Type 2, approved products include:
 - .1 Dymonic by Tremco;
 - .2 SikaFlex 15LM by Sika;
 - .3 or approved alternate.
- .2 Preformed compressible and non-compressible back-up materials:
 - .1 Polyethylene, urethane, neoprene or vinyl foam:
 - .1 Extruded closed cell foam backer rod.
 - .2 Size: oversize 30 %.
 - .2 Neoprene or butyl rubber:
 - .1 Round solid rod, Shore A hardness 70.
 - .3 High density foam:
 - .1 Extruded closed cell polyvinyl chloride (PVC), extruded polyethylene, closed cell, Shore A hardness 20, tensile strength 140 to 200 kPa, extruded polyolefin foam, 32 kg/m³ density, or neoprene foam backer, size as recommended by manufacturer.
 - .4 Bond breaker tape:
 - .1 Polyethylene bond breaker tape which will not bond to sealant.
- 2.6 **ACCESSORIES**
 - .1 Primers: Type recommended by material manufacturers for various substrates, primers to prevent staining of adjacent surfaces encountered on project.
 - .2 Joint backing: ASTM C1330; Round, solid section, closed cell, skinned surface, soft polyethylene foam gasket stock, compatible with primer and sealant materials, 30 to 50% oversized, Shore A hardness of 20, tensile strength 140 to 200 kPa. Bond breaker type surface.
 - .3 Bond breaker: Type recommended by material manufacturers.
 - .4 Void filler around the window frames to be one part expanding polyurethane foam.
 - .5 Cleaning agents: As recommended by material manufacturer, non-staining, harmless to substrates and adjacent finished surfaces.
- 2.7 **MIXING**
 - .1 Follow manufacturers instructions on mixing, shelf and pot life.
- 2.8 **JOINT CLEANER**

- .1 Non-corrosive and non-staining type, compatible with joint forming materials and sealant in accordance with sealant manufacturer's written recommendations.
- .2 Primer: in accordance with sealant manufacturer's written recommendations.
- 3 Execution**
- 3.1 EXAMINATION**
 - .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for joint sealants installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence prior to sealant installation.
 - .2 Inform the Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied. Proceeding with the installation will be the acceptance of the substrate by the Contractor.
- 3.2 SURFACE PREPARATION**
 - .1 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.
 - .2 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other
 - .3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.
 - .4 Ensure joint surfaces are dry and frost free.
 - .5 Prepare surfaces in accordance with manufacturer's directions.
 - .6 Prepare joints to receive sealants to manufacturer's instructions. Ensure that joints are clean and dry and ferrous surfaces are free from rust and oil.
 - .7 Clean recesses to receive sealant, to be free of dirt, dust, loose material, oil, grease, form release agents and other substances detrimental to sealant's performance.
 - .1 Remove lacquer or other protective coatings from metal surfaces, without damaging metal finish, using oil-free solvents. Remove rust, mill scale and coatings from ferrous metals by wire brush, grinding or sand blasting. Ensure recess is dry.
 - .2 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings. Remove incompatible coatings as required.
 - .8 Ensure that all materials in contact with sealant are compatible. Test substrate for adhesion.
 - .9 Depth of recess: Maintain depth to ½ joint width up to a maximum of 13 mm and not less than 6 mm at centre of joint. For greater depth, use joint backing under. Where recess is less than specified depth, cut back surface of recess to specified recess depth.

- .10 Install polyethylene backing rod in joints 6 mm or more in width. Roll backing rod into joint. Do not stretch or bend backing rod. Install bond breaker to back of recess.
- .11 Prime sides of recess, in accordance with sealant manufacturer's instructions.
- .12 Condition products for use in accordance with manufacturer's recommendations.

3.3 **INSTALLATION**

- .1 Apply sealant immediately after adjoining Work is in condition to receive such Work. Apply sealant in continuous bead using gun with correctly sized nozzle. Use sufficient pressure to evenly fill joint.
- .2 Ensure sealant has full uniform contact with, and adhesion to, side surfaces of recess. Superficial painting with skin bead is not acceptable. Tool sealant to smooth surface, free from ridges, wrinkles, sags, air pockets, embedded impurities, dirt, stains or other defects.
 - .1 At recesses in angular surfaces, finish sealant with flat profile, flush with face of material at each side.
 - .2 At recesses in flush surfaces, finish compound with concave face, flush with face of material at each side.
- .3 Make sealant bead uniform in colour.
- .4 Cure sealants in accordance with sealant manufacturer's instructions. Do not cover up sealants until proper curing has taken place.
- .5 Immediately remove excess compound or droppings which would set up or become difficult to remove from adjacent finished surfaces, using recommended cleaners, as work progresses. Do not use scrapers, chemicals or other tools which could damage finished surfaces. Remove defective sealant.
- .6 Clean recesses and re-apply sealant.
- .7 Remove masking tape immediately after joints have been sealed and tooled.

3.4 **PRIMING**

- .1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.
- .2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

3.5 **BACKUP MATERIALS**

- .1 Apply bond breaker tape where required to manufacturer's instructions.
- .2 Install joint filler to achieve correct joint depth and shape, with approximately 30% compression.

3.6 **APPLICATION**

- .1 Sealant:
 - .1 Apply sealant in accordance with manufacturer's written instructions to achieve the required minimum and maximum sealant depths.

- .2 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.
- .3 Apply sealant in continuous beads.
- .4 Apply sealant using gun with proper size nozzle to achieve a minimum 6mm depth over the joint profile and adhesive to substrate a minimum of 9mm, and 10mm minimum joint width, while maintaining a consistent depth-to-width ratio.
- .5 Use sufficient pressure to fill voids and joints solid.
- .6 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.
- .7 Tool exposed surfaces before skinning begins to give slightly concave shape.
- .8 Remove excess compound promptly as work progresses and upon completion.
- .9 Apply multiple application of sealant to build up the required joint-to-width ratio for joints in excess of 19mm wide, and within the manufacturer's recommendations.
- .2 Curing:
 - .1 Cure sealants in accordance with sealant manufacturer's instructions.
 - .2 Do not cover up sealants until proper curing has taken place.

3.7 **CLEANING**

- .1 Clean surfaces adjacent to joints, remove sealant smears or other soiling resulting from application of sealants. At metal surfaces, remove residue. Do not mar or damage finishes on materials adjacent to joints. Repair or replace marred or damaged materials.
- .2 Leave Work area clean at end of each day.
- .3 Clean adjacent surfaces immediately.
- .4 Remove excess and droppings, using recommended cleaners as work progresses.
- .5 Remove masking tape after initial set of sealant.
- .6 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

3.8 **PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by joint sealants installation.

3.9 **SCHEDULE OF LOCATIONS**

- .1 Following sealant location schedule is included for convenience and may not be complete. Examine Contract Drawings and other specification sections and determine entire extent of Work of this Section. Generally seal following locations:

- .1 Concrete, masonry, wood and stone to metal. Wood to masonry, concrete and stone.
- .2 Metal to metal.
- .3 All dissimilar materials.
- .4 Where 'sealant' or 'caulking' is indicated on drawings.
- .2 Sealant Type A:
 - .1 Exterior joints between masonry and steel or aluminum.
 - .2 Exterior joints between masonry and shelf angle.
 - .3 Exterior joints between steel or aluminum and concrete or masonry. Interior and exterior control joints, except in floors.
 - .4 Interior and exterior control joints, except in floors
 - .5 Door frames, louvre frames, interior and exterior side.
 - .6 Protrusions through interior and exterior walls and floors, interior and exterior side, except where fire rated seals are required.
 - .7 Seal thresholds.
- .3 Sealant Type B:
 - .1 Control joints in tiled areas.
 - .2 Between vanity and tiles
 - .3 Between mechanical fixtures/fittings.
 - .4 Between access panels and tile.
 - .5 Between tiles and adjacent materials
- .4 Sealant Type C:
 - .1 Perimeter of interior windows.
 - .2 Perimeter of counters
 - .3 Junction between drywall and masonry.
- .5 Sealant Type D:
 - .1 Exterior joints between roof and mechanical fixtures/fittings
 - .2 Perimeter of roof.

END OF SECTION

- 1** General
- 1.1** **SECTION INCLUDES**
 - .1 Labour, Products, equipment, tools, and services necessary for the metal doors and frames work in accordance with the Contract Documents.
- 1.2** **REFERENCES**
 - .1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zincron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A568/A568M, Specification for General Requirements for Steel, Carbon and High-Strength Low-Alloy, Hot-Rolled Sheet and Cold-Rolled Sheet.
 - .3 CAN4/ULC-S104M, Standard Method for Fire Test of Door Assemblies.
 - .4 CAN4/ULC-S105M, Standard Specification for Fire Door Frames, Meeting the Performance Required by CAN4/ULC-S104M.
 - .5 CAN/CGSB-1.198, Cementitious Primer, (for Galvanized Surfaces).
 - .6 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.
 - .7 CGSB 31-GP-105Ma Zinc Phosphate Conversion Coating for Paint Base
 - .8 CAN/CSA-G40.21-M92 Structural Quality Steels
 - .9 CSA W59-M89 Welded Steel Construction (Metal Arc Welding)
 - .10 NFPA 80 Fire Doors and Windows
 - .11 NFPA 252-95 Standard Methods of Fire Tests of Door Assemblies
- 1.3** **DESIGN REQUIREMENTS**
 - .1 Design exterior frame assemblies to accommodate expansion and contraction when subjected to minimum and maximum surface temperature of -35°C to 35°C.
- 1.4** **SUBMITTALS**
 - .1 Product data: Submit manufacturer's Product data in accordance with Section 01 33 00 indicating door and frame construction.
 - .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 for each type of door and frame indicating:
 - .1 Thickness and type of steel.
 - .2 Thickness and type of core.
 - .3 Thickness and type of steel stiffeners and location of them within the door.
 - .4 Thickness and type of metal facing on edges of door and method of fastening.
 - .5 Location of mortises, reinforcement, anchorages, joining, welding, sleeving, exposed fasteners, openings and arrangement for hardware.

- .2 Include schedule identifying each unit with door marks and numbers relating to numbering on Contract Drawings and in door schedule
- .3 Mill Certification: Submit mill certification on all materials used to fabricate items specified.

1.5 **QUALITY ASSURANCE**

- .1 Perform work in accordance with requirements by a member of the Canadian Steel Door and Frame Manufacturers Association.
- .2 Label and list fire rated doors and frames by an organization acceptable to authorities having jurisdiction and accredited by the Standards Council of Canada in conformance with CAN4/ULC-S104M and CAN4/ULC-S105M for ratings indicated, labelling shall be in accordance with NFPA 80.

2 **Products**

2.1 **ACCEPTABLE MANUFACTURERS**

- .1 Apex Industries
- .2 Daybar Industries Limited
- .3 Fleming Doors Products.
- .4 Steel-Craft Door Products Ltd

2.2 **MATERIALS**

- .1 General:
 - .1 All materials under work of this Section, including but not limited to, primers are to have low VOC content limits.
 - .2 Materials used for the door & frame construction in this section to conform to: CAN/CSA-G40.21, Type 44W coating designation to ASTM A653.
 - .3 Galvanized Steel Sheets: (G90) Mill phosphatize in addition to coating specified at referenced HM standard. Provide at shower, washrooms doors and frames and other doors and frames where indicated as well as at exterior doors and frames.
 - .4 Supports and Anchors: Same material as frame including gage and galvanizing where indicated.
 - .5 Inserts, Bolts, and Fasteners: Manufacturer's standard units. Hot-dip galvanize in compliance with ASTM A 153, Class C or D as applicable at exterior walls and where opening is indicated to be galvanized.
 - .6 Provide shop primers for security hollow metal doors & frames were welded.
- .2 Minimum base steel thickness:
 - .1 Frames 2.7 mm G90 Galvanized steel
 - .2 Typical doors 1.91 mm G90 Galvanized steel faces

- | | | |
|----|----------------------------|--------|
| .3 | Lock/strike reinforcements | 1.6 mm |
| .4 | Hinge reinforcements | 2.7 mm |
| .5 | All other reinforcement | 1.6 mm |
| .6 | Top and bottom channels | 1.2 mm |
| .7 | Glazing stops | 0.9 mm |
| .8 | Guard boxes | 0.9 mm |
| .9 | Jamb spreaders | 0.9 mm |
- .3 Top caps and thermal breaks: CGSB 41-GP-19Ma; Rigid PVC extrusions.
- .4 Primer: CAN/CGSB 1.198.
- .5 Door material:
- .1 Interior and Exterior Doors: Provide minimum 1.91 mm (14 gauge) sheet G90 galvanized steel faces.
 - .2 Stiffeners: Provide 16ga A40 galvanneal stiffeners to extend full height top to bottom and maximum 75 mm(3") from door sides. Where stiffeners are not continuous between face sheets, weld internal joints 100 mm (4") o.c. max. Cope at hardware preparations only. Provide one of the following stiffener types:
 - .3 Edge Channels: Continuously weld to both face sheets.
 - .4 Flush Closing Channels: Continuously weld to both face sheets.
 - .5 Insulation: Core mineral fiber 48 kg/cubic meters density minimum.
 - .6 Hardware Reinforcements and Preparations: Comply with referenced HM standard and the following:
 - .1 Strike Plate: Do not cut edge channel to receive entire strike or keeper. Provide punched opening to engage bolt in edge channel matching cut-out in strike plate.
 - .2 Drilling and tapping for surface applied hardware may be done at project site.
 - .7 Exterior doors: Rigid poly/isocyanurate, closed cell insulation, 32 kg/m3, thermal value: RSI 1.9.
 - .8 Fire rated doors: Mineral fibre insulation to CAN/ULC S702, Type 1A; 24 kg/m3.
- .6 Screws: Stainless steel screws with countersunk flat head.
- .7 Door silencers: Type 6-180, black neoprene.
- .8 Frame anchors:
- .1 Frames in masonry: 1.2 mm minimum, adjustable T-strap jamb anchors.

- .2 Frames in steel stud partitions: 0.9 mm minimum steel anchors of suitable design securely welded inside each jamb.
- .3 Frames in precast: Countersunk galvanized expansion bolts complete with galvanized anchor, base anchors, and spacers behind hollow metal frame.
- .4 Frames in existing masonry/concrete/precast walls: 0.9 mm minimum frame anchors to suit design.
- .5 Labeled frames: In accordance with ULC requirements.
- .9 Floor anchors: 1.6 mm minimum adjustable floor clip angles with 2 holes for anchorage to floor.
- .10 Labels for fire doors and door frame: Brass plate, riveted to door and door frame.
- .11 Grilles: Corrosion resistant steel with baked enamel finish. Model 61DG Series by Nailor Industries Inc or approved alternative by Hart and Cooley.
- .12 Glass and glazing: In accordance with Section 08 80 00.

2.3

FABRICATION

- .1 General
 - .1 Fabricate doors and frames in accordance with reviewed shop drawings.
 - .2 Welding: CSA W59-M to produce a finished unit with no visible seams or joints, square, true and free of distortion.
 - .3 Welding: Continuous unless specified otherwise. Execute welding by a firm fully acceptable to the Canadian Welding Bureau to requirements of CSA W47.1.
 - .4 Form profiles accurately to details shown on Contract Drawings.
 - .5 Ream and remove burrs from drilled and punched holes.
 - .6 Grind welded corners and joints to a flat plane and fill with metallic filler and sand to a uniform smooth finish. Apply one coat of primer.
 - .7 Provide weather strip for exterior doors in accordance with Section 08 70 00 and door manufacturer.
- .2 Frames and screens:
 - .1 Fabricate frames of welded construction. Cut mitres and joints accurately and weld continuously on inside of frame profile. Exterior frames to be thermally broken.
 - .2 Construct large frame sections with provision for on Site assembly to suit Site conditions.
 - .3 Blank, reinforce, drill and tap frames for mortised, templated hardware. Protect mortised cut-outs with guard boxes.
 - .4 Reinforce frames where required for surface mounted hardware.

- .5 Reinforce frames over 1200 mm wide with roll formed steel channels or hollow structural sections specified in Section 05 50 00 and as indicated on drawings.
- .6 Furnish exterior door frames with a continuously welded integral steel weather drip at head of frame.
- .7 Prepare each door opening for single stud rubber door silencers, 3 for single door openings located in strike jamb, and 2 for double door openings located in head.
- .8 Install 2 channel or angle spreaders per frame, to ensure correct frame alignment. Install stiffener plates or spreaders between frame trim where required, to prevent bending of trim and to maintain alignment when setting in place.
- .9 Form channel glazing stops minimum 16 mm height, accurately cut, mitred, fitted and fastened to frame sections with stainless steel counter-sunk, flat head screws spaced at maximum 450 mm throughout and 50 mm from each end.
- .10 Frame Fill: Prepare heads, jambs, and sills abutting structure, walls, or floors for solid anchorage with full grout fill. Exclude grout from mullions except where otherwise indicated.
 - .1 Grout Guards: At frames to be grouted, tightly weld 0.45 mm(0.018") minimum steel grout guards at screw holes, cut outs, and hardware preparations including those for removable glazing stops, locksets, pushbuttons, strike plates, hinges, etc. Additionally at hinge preparations Contractor to provide polyurethane or polystyrene foam fill or otherwise tightly seal grout guards to keep screw holes grout free.
- .3 Anchorage:
 - .1 Anchor units to floor and wall construction. Locate each wall anchor immediately above or below each hinge reinforcement on hinge jamb and directly opposite on strike jamb, minimum number of anchors for each jamb:
 - .1 Frames up to 2285 mm 3 anchors.
 - .2 Frames from 2285 mm to 2440 mm 4 anchors.
 - .2 Where frames are to be set in masonry or concrete, supply adjustable anchors to trade installing frame.
 - .3 Fabricate frames for installation in steel stud partitions with steel anchors of suitable design, minimum number of anchors for each jamb:
 - .1 Frames up to 2285 mm height 4 anchors.
 - .2 Frames 2285 mm to 2440 mm 5 anchors.

- .4 Frames in previously placed concrete, masonry, precast or structural steel:
 - .1 Anchors located at 150 mm maximum from top and bottom of each jamb, and intermediate anchors at maximum 660 mm o.c.
- .4 General Door Requirements:
 - .1 Hollow steel construction, flush swing type, of sizes to conform to details, schedules and reviewed shop drawings with provisions for cut-outs for glass and grilles and reinforced to receive hardware fastenings.
 - .2 Blank, reinforce, drill and tap doors for mortised, templated hardware. Where required, reinforce doors for surface mounted hardware and door closers.
 - .3 Reinforce oversized doors with steel channels and plates specified in Section 05 50 00 and as indicated on drawings.
 - .4 Where openings are required, form integral cut-outs with framing, glass stop moldings and division bars.
 - .5 Install grilles to fit tight and secure into openings.
 - .6 Bevel both stiles of single doors 1 in 16.
 - .7 Reinforce doors with galvanized metal stiffeners at 150 mm o.c.
- .5 Interior Doors:
 - .1 Supply and install inverted, recessed, mechanically interlocked with tack welded channels at top and bottom of doors.
 - .2 Fabricate doors with joints between front and back panels meeting on stile edges. Make joints mechanically interlocked and tack welded for entire height of door. After welding has been completed, grind joints smooth to match metal. Ensure that no filler is used in joints.
 - .3 Fill hollow space within door and vertical stiffeners from top to bottom with mineral fibre batt insulation.
- .6 Exterior Doors:
 - .1 Supply and install inverted, recessed, mechanically interlocked with tack welded channels at top and bottom of doors. Supply and install PVC top caps.
 - .2 Fabricate doors with joints between front and back panels meeting on stile edges. Make joints mechanically interlocked and tack welded for entire height of door. After welding has been completed, grind joints smooth to match metal. Ensure that no filler is used in joints.
 - .3 Fill hollow space within door from top to bottom with rigid polyisocyanurate insulation.
- .7 Fire Rated Doors:

- .1 Supply and install inverted, recessed, spot welded channels at top and bottom of doors. Supply and install steel flush top caps on exterior doors.
- .2 Fabricate doors with joints between front and back panels meeting on stile edges. Make joints continuously welded for entire height of door. After welding has been completed, grind joints smooth to match metal. Ensure that no filler is used in joints.
- .3 Fabricate doors to achieve fire rating as indicated on drawings and in accordance with ULC. Provide ULC label plate on door at hinged edge midway between top hinge and head of door.

3 Execution

3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 HOLLOW METAL DOOR AND FRAME INSTALLATION

- .1 Install hollow metal doors and frames plumb, square, level, secure, and at correct elevation.
- .2 Install doors clear of floor finishes, and with the correct rebate opening for the door installation. Install door silencers.
- .3 Secure anchorages and connections to adjacent construction. Brace frames rigidly in position while building-in. Remove temporary steel shipping jamb spreaders. Install wood spreaders at third points of frame rebate height to maintain frame width. Supply and install vertical supports as indicated on drawings for openings over 1200 mm in width. Remove wood spreaders after frames have been built-in.
- .4 Allow for structural deflection and prevent structural loads from being transmitted to hollow metal frames.
- .5 Touch-up areas where galvanized coating has been removed or damaged with primer.
- .6 Fire rated doors: Install fire rated doors and frames in accordance with requirements of NFPA 80.

3.3 ADJUSTING AND CLEANING

- .1 Adjust doors for smooth and balanced door movement.
- .2 Clean doors and frames.

END OF SECTION

1 General

1.1 SECTION INCLUDES

- .1 Labour, Products, equipment and services necessary for painting work in accordance with the Contract Documents.

1.2 REFERENCES

- .1 ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

1.3 DESIGN REQUIREMENTS

- .1 Stacking:
 - .1 Minimum stacking shall be 1.05 inches/linear foot (87.5 mm/meter) of opening plus 3.5 inches (89 mm) for each locking member.
 - .2 Grille support must be designed to carry the weight of a fully stacked door at any point along its length. Support is to carry the total weight / the total stacking and is expressed as lbs./lin. ft.
 - .3 Lintel Deflection: Accommodate deflection of lintel to prevent damage to components, deterioration of seals, or movement between door frame and perimeter framing.
 - .4 Thermal Movement: Design sections to permit thermal expansion and contraction of components to match perimeter opening construction.

1.4 SUBMITTALS

- .1 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Indicate opening dimensions, curves, type of locking posts, elevations and framed opening tolerances.
 - .2 Product Data: Manufacturer's data sheets on each product to be used, including:
 - .1 Preparation instructions and recommendations.
 - .2 Storage and handling requirements and recommendations.
 - .3 Installation methods.
 - .3 Close-out submittals: Submit data for incorporation into the Operations and Maintenance Manual as part of Section 01 33 00.

1.5 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: A company that specializes in the manufacturing of the folding grille products required for the project with a minimum of 10 years documented experience.
- .2 Installer Qualifications: Contractor that has minimum of two years documented experience installing folding grille products similar to those

specified.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Store products in manufacturer's unopened packaging until ready for installation.
- .2 Protect finished surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to substrate when exposed to sunlight or weather
- .3 Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.
- .4 Store materials in a ventilated weather tight location.

1.7 COORDINATION

- .1 Coordinate Work with other operations and installation of finish materials to avoid damage to the materials.

1.8 EXTENDED WARRANTY

Manufacturers standard limited product warranty for a period of two years.

2 Products

2.1 ACCEPTABLE MANUFACTURER(S) AND SYSTEM(S):

- .1 Acceptable Manufacturer: Amstel Manufacturing (1993) Inc, 128 Centre Street East, Richmond Hill, Ontario. L4C 1A6. Canada.
- .2 Substitute products by the following manufacturers are accepted:
 - .1 Cornell Iron Works Inc.
 - .2 The Cookson Company, Inc.
 - .3 McKinlay Door Sales door solutions.

2.2 MATERIALS

- .1 AS400 PERFORATED VISTA Sliding Security Grille
 - .1 Curtain:
 - .1 Panels to have full height butt hinges on 7 inches (178 mm) centers.
 - .2 Panels to have 4 inches (102 mm) high truss-like plates at the top and bottom of the closure.
 - .3 Panel Inserts are separated by 1" height aluminum extrusions with "T" shaped ends to fit into full height aluminum extruded channels for added strength.
 - .4 Constructed of 6 inches (152 mm) wide by 1/8 inch (3.2 mm) thick steel panel inserts with perforated round holes set in a staggered pattern.
 - .5 Perforated Panels are sandwiched between P.V.C. gaskets..
 - .2 Weight: AS400 Perforated Vista: 2.0 lbs./sq. ft. (9.7 kg/sq.m).

- .3 Aluminum is to be 6063 aluminum alloy with T-5 temper conforming to ASTM B 221.
- .4 Locking:
 - .1 Lead Posts:
 - .1 Provide (#7) hook bolt post with a concealed hook bolt lock activated by a keyed cylinder or thumb turn that engages hook bolt into full height wall channel
 - .2 Provide (#2) top and bottom post with top rod and bottom ratcheted rod activated by a keyed cylinder or thumb turn. Provide rubber bumper at edge of locking post.
 - .2 End Posts:
 - .1 Provide (#7) hook bolt post with a concealed hook bolt lock activated by a keyed cylinder or thumb turn that engages the hook bolt into full height wall channel.
 - .2 Provide (#2) top and bottom post with top rod and bottom ratcheted rod activated by a keyed cylinder or thumb turn. Provide rubber bumper at edge of locking post.
 - .3 Floor Sockets:
 - .1 Standard: Supply Stainless Steel dustproof floor sockets for all drop bolts.
 - .4 Track:
 - .1 Overhead track shall be 1.3 inches (33 mm) wide by 1.8 inches (46 mm) high and sized to accept 1-1/8 inches (29 mm) diameter roller trolleys.
 - .2 Rollers bear on 0.27 inch (7 mm) thick aluminum surface within the track.
 - .5 Factory Finishes:
 - .1 Use two letter suffix to denote required door finish.
 - .2 Standard: AA, Clear Anodized, 0.0004 inch (10 micron) clear anodizing.

2.3 ACCESSORIES

- .1 Fasteners: Galvanized or corrosion resistant steel.

2.4 FABRICATION

- .1 Size and fabricate grille assembly to allow for tolerances of rough framed openings, clearances, shim spacing and shims around perimeter of assemblies.
- .2 Ensure joints and connections are flush and hairline.
- .3 Accurately and rigidly fit joints and corners. Fabricate doors of welded construction.

3 Execution

3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section

depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

- .2 Do not begin installation until substrates have been properly prepared and are able to carry the weight of the folded grille.
- .3 Verify openings are ready to receive work and opening dimensions and clearances are as indicated on shop drawings.
- .4 Provide full size template or CAD file for custom radius track prior to fabrication.
- .5 If openings are the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- .1 Clean surfaces thoroughly prior to installation.
- .2 Prepare surfaces as recommended by the manufacturer for achieving the correct installation under the project conditions.
- .3 Examine supports and other conditions under which closures are to be installed.
- .4 Coordinate with responsible entity to correct unsatisfactory conditions and do not proceed with installation until conditions are corrected.

3.3 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Attach frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.
- .3 Use anchoring devices that securely fasten sliding door assembly to wall and ceiling construction without distortion or imposed stresses.
- .4 Separate aluminum and other corrodible surfaces from sources of corrosive of electrolytic action at points of contact with other materials.
- .5 Adjust hardware for smooth operation.
- .6 Install doors as shown and in accordance with manufacturer's printed instructions.
- .7 Fasten door guides and associated components securely to walls using anchors where required.
- .8 Supply and install all necessary steel, brackets, clips, angles, supports, anchors, etc., which may be required to support the door and mechanisms.
- .9 Erect door true to line with all hardware carefully and neatly applied. Make all necessary adjustments and leave door in proper working order.
- .10 Install chain drop in location indicated.
- .11 Adjust door operating components to ensure smooth opening and closing of doors.
- .12 Materials are to be installed by the manufacturer or an authorized representative. Prior to commencement of the work of this section, examine and be assured that conditions will permit a proper installation.

- .13 Assemble and erect work plumb, true, square, straight, level and accurate to sizes detailed, to reviewed shop drawings, free from distortion and defects detrimental to appearance and performance.
- .14 Isolate metals where necessary to prevent corrosion due to contact between dissimilar metals and between metals and masonry, concrete or plaster. Use bituminous paint or butyl tape.
- .15 Supply adequate instructions, templates, and if necessary, supervise installation of the fastenings or accessories requiring to be built-in by work of other sections.

3.4 ERECTION TOLERANCES

- .1 Maintain dimensional tolerances and alignment with adjacent work and as follows:
 - .1 Maximum variation and alignment from plum: 1.5 mm.
 - .2 Maximum variation from level: 1.5 mm.
 - .3 Longitudinal or diagonal warp: Plus or minus 3 mm per 3 m straight edge.

3.5 FIELD QUALITY CONTROL

- .1 Testing: Test operate door and demonstrate the operation of same to the satisfaction of the Consultant.
- .2 Adjust door operating components to ensure smooth opening and closing of doors.
- .3 Upon completion of work of this section, clean down material, lubricate and adjust operation as required to obtain optimum performance.

3.6 CLEANING

- .1 Remove protective material from factory finished surfaces.
- .2 Remove temporary labels and visible markings

3.7 PROTECTION

- .1 Protect installed products until completion of project.
- .2 Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

PART 1 – GENERAL

1.1 WORK INCLUDED

- .1 Furnish, deliver and install finish hardware.
- .2 It is intended that the following list of hardware will cover finish hardware to complete the project. Bring to the Consultants attention any omissions, discrepancies that will affect work in this section during the bidding period.

1.2 RELATED SECTIONS

- .1 General Requirements Division 1
- .2 06 20 00 Finish Carpentry
- .3 08 11 13 Doors and Frames
- .4 08 44 00 Aluminum Framed Glazing System
- .5 Division 26 Electrical
- .6 Division 28 Electronic Safety and Security

1.3 PRODUCTS SUPPLIED BUT NOT INSTALLED IN THIS SECTION

- .1 Power supplies, compressor/control boxes, junction boxes installed by Division 26.

1.4 REFERENCES

- .1 Door and Hardware Institute - Recommended locations for Architectural Hardware for Standard Steel Doors and Frames
- .2 Door and Hardware Institute - Recommended locations for Architectural Hardware for Flush Wood Doors
- .3 NFPA 80-Standard for Fire Doors and Windows, 1999 Edition
- .4 Door and Hardware Institute - Sequence Format for Hardware Schedule
- .5 Door and Hardware Institute - Key Systems and Nomenclature
- .6 Door and Hardware Institute - Abbreviations and Symbols used in Architectural Door and Hardware Schedules and Specifications
- .7 Door and Hardware Institute – Installation Guide for Doors and Hardware
- .8 Ontario Building Code 2012

1.5 SUBMITTALS

- .1 Updated Finish Hardware Schedule:

Submit submittals in accordance with Section 01 33 00 Submittal Procedures.
Prepare detailed hardware schedules in Door and Hardware (DHI) vertical format as detailed in Reference 1.4.4.
- .2 Product Data:

Submit in a three-ring binder six (6) copies of product data sheets with the finish hardware schedule showing items of hardware to be used on the project.
- .3 Samples:

When requested in writing, provide (to the Consultants Site Office) one sample of each hardware item complete with fasteners, within thirty (30) calendar days of award of a purchase order. Samples to be clearly labeled with their hardware schedule designation and manufacturers' name and model number. Samples will be incorporated into the work.
- .5 Templates:

Submit templates within to related trades when requested.
- .6 Keying Schedule:

After a keying meeting between representatives of the Owner, furnish a keying schedule listing the levels of keying as well as an explanation of the key system's function, the key symbols used, and the door numbers controlled. Utilize "Door and Hardware Institute - Key Systems and Nomenclature" as a guideline for nomenclature, definitions, and approach for selecting the optimal keying system. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
- .7 Wiring Diagrams
Co-ordinate with related trades, meet with the owner and security provider and submit a written description of the functional use (mode of operation) of electrical hardware products specified. Include operation for ingress, egress, fire alarm, and after hours use where applicable. Include door and frame elevations showing the location of each item of electrical hardware to be installed, mode of operation including a diagram showing number and size of conductors. Indicate on elevation drawing items provided by related trades, include for back boxes, and 120V power sources. Provide point to point drawings showing terminal connections necessary for a complete installation.
- .8 Operations and Maintenance Data

Prior to Substantial Completion, furnish to the owner, three (3) copies of an owner's operation and maintenance manuals in a three-ring binder with the following information:

1. Name of hardware distributor, address and contact name
2. Copy of final "as-built" finish hardware schedule
3. As installed "wiring diagrams, elevations, risers, point to point"
4. Copy of final keying schedule
5. Copy of floor plans with keying nomenclature assigned to door numbers as per the approved keying schedule
6. Catalogue cut sheets and product specifications for each product
7. Parts list for each product
8. Installation instructions and templates for each product

1.7 QUALITY ASSURANCE

- .1 Review installation procedures with the Contractor's Designated Installers. Hold instruction meetings with installers prior to installation and subsequent review meetings during the installation period. Submit minutes of meetings to the Consultant.
- .2 Substitutions
Only approved products specified are accepted. Make substitution requests in accordance with Division 1. Include product data and indicate benefit to the project.
- .3 Supplier Qualifications
Successful hardware distributor to have a minimum of five (5) years' experience in the door and hardware industry. Distributor to have on staff an Architectural Hardware Consultant (A.H.C.) whose name will be listed on the hardware schedule title page submittal and will be responsible for scheduling, detailing, (see Reference 1.5.4) ordering and co-ordination of the finishing hardware for this project. If so, requested by the Consultant and or installer this individual will be required to visit the jobsite for any installation problems that may occur.
- .4 Designated Installers
Hardware Installers must have a minimum of five (5) years' experience in installation of hardware. Provide verification of installer's qualification to Consultant for approval. Installers to attend review meetings with the Hardware Distributor.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Marking and Packaging
Mark cartons with heading number, door number, and key-set symbol where applicable in original packaging provided by the manufacturer. Pack packaged hardware in suitable wrappings and containers to protect it from damage during shipping and storage.
Enclose accessories, fastening devices and other loose items with each applicable item of hardware.

- .2 Delivery
Deliver hardware to related trades.
- .3 Storage
Store in a clean, dry room with lockable man door and adequate shelving to permit organization so item numbers are readily visible.

1.9 WARRANTY

- .1 Furnish warranties by the accepted manufacturers:

Hardware Item	Length of Warranty
Mortise Hinges	1 year
Locks (Mortise)	3 years
Exit Devices	3 years
Door closer – 4040XP	30 years
Floor/Wall stops	1 year

1.10 MAINTENANCE

- .1 Maintenance Service
After the building is occupied arrange an appointment with the maintenance staff from the City of Toronto for instruction of proper use, servicing, adjusting and lubrication of hardware furnished. Submit to the consultant a list of attendees and meeting date.
- .2 Extra Materials
Furnish the following items in proper manufacturer's cartons once the job has been completed:
 - 1. 5 of each installation tool used for locks/passage/privacy, type of door closers, and exit devices.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

Products listed in the hardware groups are from the manufacturers listed below:

ITEM	MANUFACTURER NAME
Full Mortise Hinges	Ives
Locksets, Latchsets/Deadbolts	Schlage
Cylinders	Schlage
Exit Devices	Von Duprin
Door Closers	LCN
Overhead Door Holders/Stops	Glynn Johnson
Wall/Floor Stops	Ives
Weather/Smoke/Sound Seals	Zero
Door Sweeps/Thresholds	Zero

2.1 MATERIALS

1. Screws and Fasteners:

Screws and fasteners to be matching finish to their product and to be manufacturer's standard. Door closers, door holders and exit devices installed on fire rated wood doors and hollow metal doors to be attached with fasteners to meet NFPA 80 requirements.

2. Materials-Acceptable Manufacturers (Note: Supply products in a given category from the same manufacturer):

.1 Mortise Hinges

Provide five knuckle bearing hinges with NRP option on reverse bevel doors with locking hardware. Hinge width to accommodate door closer projection, door trim and allow for 180-degree swing. Doors up to 2286mm (90") in height, supply 3 hinges, doors greater than 2286mm in height add one hinge for every additional 760mm of door height. Doors 915mm (36") wide and less furnish 114mm (4-1/2") high hinges, doors greater than 915mm (36") wide furnish 127mm (5") high hinges, heavy weight or standard weight as specified. Supply ferrous (steel), stainless steel material for all interior and/or fire-rated doors and stainless steel for exterior doors.

As Specified: Ives Hinges, 5BB1, 5BB1HW

.2 Locksets/Deadlocks/Privacy Sets:

Mortise:

Grade 1 Operational, Grade 1 Security, mortise lock for commercial and institutional buildings. Manufacture lock cases from fully wrapped, heavy 12 gage steel with a protected leading edge and screw configuration that limits access to operating parts. Lock components to be manufactured of zinc dichromate plated steel. Latch bolts to have a standard 70mm (2 3/4") backset with a full 19mm (3/4") throw. Latchbolts to be non-handed, field reversible without opening the lock case. Latchbolts to be 2-piece anti-friction, manufactured from stainless steel. Solid latchbolts and/or plastic anti-friction devices are not acceptable. Deadbolts to be 45mm (1 3/4") total length have standard 25mm (1") throw with a minimum 19mm (3/4") internal engagement when fully retracted. Deadbolts to be constructed of stainless steel, incorporating a security roller pin with a minimum Rc60 rating for surface hardness. Lever assembly (external) to be one-piece design attached by threaded bushing. Lever assembly (internal) to be attached by screw less shank. Lever attachments by common tools (allen nuts and/or set screws) are not acceptable. Thru bolt lever assemblies through the door for positive interlock. Levers to have independent rotation in both directions. Lever operation to be freewheeling (clutch) when in the locked mode. Spring cages are to be

incorporated into the lever assemblies. Hub blocking plate to be solid, cast stainless steel. Manufacturers utilizing open hub designs are not acceptable. Spindles to be independent, designed to “break away” at a maximum of 75psi torque. Mounting tabs are to be automatic self-adjusting, vertically and horizontally for door bevel and strike alignment. Cylinders to be secured by a cast stainless steel, dual retainer. Manufacturers utilizing screws and/or stamped retainers are not acceptable.

Supply as Specified: Schlage “L” series

.3 Exit Devices/Device Trims/Mullions:

Heavy Duty

Exit device to be cUL listed for panic hardware and fire exit hardware. Supply panic hardware and fire exit devices featuring coil compression springs on device mechanism subassemblies and dead latching mechanisms for active latch bolts. Supply exit devices with smooth mechanism case and “the quiet one” fluid dampener to eliminate noise associated with exit device operations. Non-handed device with touchpad assemblies with no exposed fasteners and cast end caps, reinforced aluminum with stainless steel touchpad and raised edge to minimize pinching. Roller strikes to be standard on rim and surface vertical rod devices, mortise exit devices (626) complete with strikes that match the same finish as the device. Doors greater than 950mm (37-13/32”) wide supply long bar exit devices, doors greater than 2134mm (84”) high supply extension rods for surface vertical rod series. 1,000,000cycle testing independently certified by ETL.

Supply as Specified: Von Duprin 98 series

Exit Device Trim

Supply device trim featuring recessed cylinder mounting and coil compression spring design with shear pin protection for lever designs. Similar lever designs for exits as specified for locksets.

Supply as Specified Von Duprin 996 series

.4 Door Closers:

Door closers to have the following Fully hydraulic, rack and pinion action with high strength cast iron and one-piece forged steel pistons.

- Include high efficiency, low friction pinion bearings.
- Hydraulic fluid of a type requires no seasonal adjustments, ULTRA X TM fluid has constant temperature control from -35 degrees Celsius to +49 degrees Celsius.
- Hydraulic regulation controlled by tamper-proof, non-critical screw

- valves, adjustable with a hex wrench.
- Separate adjustments for backcheck, general speed and latch speed.
- Door closers with special template (ST-) numbers include required associated product, information sheets and instructions
- Size 1 manual door closers to provide less than 5 pounds opening force on a 900mm door leaf.
- Door closer with Pressure Relief Valves are not accepted.
- Door closer bodies, arms, covers to be powder coated
- Closers with powder coat finishes to exceed a minimum 100-hour salt spray test, as described in ANSI A156.18 and ASTM B117.
- Closers detailed with plated finishes to include plated covers (or finish plates), arms and visible fasteners.

Medium Duty Mechanical (Interior/Exterior):

Non-sized (1-6) and non-handed cylinder body to have 32mm (1 ¼") piston diameter with 16mm (5/8") single heat-treated shaft. Track closer cylinder body non-sized (2-4) or (1-2). Closers to have stamped main arm and forearm (forged steel main arm and forearm EDA and CUSH type arms). Optional arms to be interchangeable within the series of closers, except track arm type closers. Track arm type closers to have single lever arm with low friction track and roller assembly and provisions for an optional bumper to assist backcheck.

Supply as Specified: LCN1460 HD series

Heavy Duty Mechanical (Multiple Applications):

Non-sized (1-6) and non-handed cast iron cylinder body to have 38mm (1 ½") diameter with 19mm (¾") journal double heat-treated pinion shaft with 16mm (5/8") full complement bearings. XP closer hydraulic regulation controlled by tamper-proof, non-critical screw valves, abrasion resistant Vitron "O" ring, adjustable with a hex wrench. Closer to have "FAST" Power Adjust speed dial to show spring size power. Track closers non-sized 1-4. Closers to have forged steel main arm and forearm (forged steel main arm and forearm EDA and CUSH type arms). Optional arms to be interchangeable within the series of closers, except track arm type closers. Track arm type closers to have single lever forged arm with low friction track and roller assembly and provisions for an optional bumper to assist backcheck.

Supply as Specified: LCN 4040XP series

"NOTE: LOW ENERGY OPERATORS SUPPLIED AND INSTALLED BY THIS SECTION"

Heavy Duty Electric Operator

Provide low energy automatic operator units that are electro-mechanical design.

Powered by DC motor working through reduction gears. Spring force closing.

Motor is off when door is in closing mode. Door can be manually operated with power on or off without damage to operator. Provide variable adjustments, including opening and closing speed adjustment. Provide units with manual off/auto/hold-open switch, push and go function to activate power operator, vestibule interface delay, electric lock delay, hold-open delay adjustable from 2 to 30 seconds, and logic terminal to interface with accessories, mats, and sensors. Provide full length aluminum header, drop plates, angle brackets, or adapters for arms to suit details. Sequence operation of exterior and vestibule doors with automatic operators to allow ingress or egress through both sets of openings, consult with owner.

Supply as Specified: LCN 9500

.5 Overhead Door Stops/Holders:

Heavy Duty Surface Mounted:

Surface overhead stops/holders to be stainless steel base, non-handed for single-acting doors with a heavy-duty channel/slide-arm design and offset jamb bracket to allow for simple field modifications of functions. Channel to be surface mounted to the door with thru bolts and the jamb bracket is surface mounted to the frame soffit.

Supply as Specified: Glynn-Johnson 90 series

Medium-Duty Surface Mounting:

Surface overhead stops/holders to be stainless steel base, non-handed for single-acting doors with a channel/slide-arm design and offset jamb bracket to allow for simple field modifications of functions. Channel to be surface mounted to the door with thru bolts and the jamb bracket is surface mounted to the jamb.

Supply as Specified: Glynn-Johnson 450 series

.6 Door Pulls/Flatware/Coat Hooks:

Ives 8400 B-NH-A, tape mounting for installation (Kickplates 40mm (1-5/8") less door width single door and 25mm (1") less door width double doors)

.7 Floor/Wall Stops:

Wall Stops (No Button on Locking Hardware):

Wall stops to be constructed of stainless-steel base with special retainer cup that makes the rubber stop tamper resistant. Convex design of rubber bumper.

Supply as Specified: Ives WS407CVX

.8 Weather/Smoke/Sound Seals:

Supply as Specified: Zero 429AA (head seal)

Note: Mount head seal prior to soffit mounted hardware.

Zero 328AA-S (jamb seal, head/jamb seal)

Zero 188SBK (head/jamb seal)

Zero 8192AA (door sweep)

.9 Thresholds/Weatherstrip/Door Sweeps:

Supply as Specified: Zero 625A(Threshold)

2.3 FINISHES

.1 Unless otherwise specified, finishes to be brushed chrome (BHMA 626/652).

Finishes are specified as follows:

ITEM	BHMA#	DESCRIPTION	BASE MATERIAL
Hinges	630	satin stainless steel	stainless steel
Hinges	652	satin chrome plated	steel
Pivots	689	powder coat aluminum	steel
Lock Trim	626	satin chrome plated	brass/bronze
Exit Devices	626	satin chrome plated	brass/bronze
Protective Plate	630	satin stainless steel	stainless steel
Door Stops/holders			
Overhead	630	satin stainless steel	stainless steel
Wall/Floor	626	satin chrome plated	brass/bronze
Thresholds	628	anodized aluminum	aluminum
Weatherstrip	628	anodized aluminum	aluminum

2.4 [KEYING - STANDARD KEYING WITH EXTERIOR PRIMUS CYLINDERS]

CYLINDERS, KEYING SYSTEMS AND KEY CONTROL

.1 Meet with the Owner to finalize keying requirements and obtain keying instructions in writing as outlined in Division 1. Locks, cylinders and keys shall be

furnished with Schlage patented full size key sections.

- .2 Provide temporary construction keying system during construction period. Permanent keys will be furnished to the Owner's Representative prior to occupancy. The Owner or Owner's Security Agent will void the operation of the construction keys.
- .3 Permanent cylinders to be keyed by factory, combined in sets or subsets, master keyed or great grand master keyed, as directed by Owner. Permanent keys, keyblanks and cylinders shall be stamped with the applicable blind code for identification. These visual key control marks or codes will not include the actual key cuts. Stamp cylinders with concealed visual keying for added security. Permanent keys will also be stamped "Patented". Keys and cylinder identification stamping to be approved by the Consultant and Owner. Failure to properly comply with these requirements may be cause to require replacement of the cylinders and keys involved as deemed necessary at no additional cost to the Owner.
- .4 Equip locks and cylinders with patent protected, full size cylinders with nickel silver blocking pin to check for patented feature on keys. Provide a minimum of six pins with nickel silver bottom pins. Cylinders must allow for multiplex master keying, combined to Owner's instructions.
- .5 Provide complete cross-index system, place keys on markers and hooks in the cabinet as determined by the final key schedule. Provide one each key cabinet, hinged panel type cabinet for wall mounting. See hardware groups for model number.
- .6 Deliver permanent key blanks and other security keys direct to Owner's representative from factory by secure courier, return receipt requested. Failure to properly comply with these requirements may be cause to require replacement of cylinders and keys involved as deemed necessary at no additional cost to the Owner.

Key Management Software

PART 3 – EXECUTION

3.1 EXAMINATION

- .1 Ensure that doors and frames are prepared and reinforced to receive finish hardware prior to installation.
- .2 Ensure that door frames and finished floor are plumb and level to permit proper engagement and operation of hardware.
- .3 Verify power is run to door opening requiring electrified hardware.
- .4 Submit in writing a list of deficiencies determined as part of inspection required in 3.1.1 and 3.1.2 to supervising consultant prior to installation of finished hardware.

Correct door frame installation before proceeding with finish hardware installation.

3.2 INSTALLATION

- .1 Hardware Installers must have a minimum of five (5) years' experience in installation of hardware.
Provide verification of installer's qualification to Consultant for approval. Installers to attend review meetings conducted by the hardware distributor.
- .2 Install hardware at mounting heights as specified in the manufacturer's templates or specific references in approved hardware schedule or approved elevation drawings.
- .3 Where mounting height is not otherwise specified, install hardware at mounting heights as indicated in 1.5.1, 1.5.2.
- .4 Install hardware using only manufacturer supplied and approved fasteners in strict adherence with manufacturers published installation instructions.
- .5 Ensure locksets / latchsets / deadlocks are of the correct hand before installation to ensure that the cylinder is in the correct position. **Handing is part of installation procedure.**
- .6 Ensure that exit devices are of the correct hand and adjust device cam/drive screw for proper outside trim function prior to installation. Handing is part of installation procedure.
- .7 Follow manufactures installation instructions. Adjustment of door closers is inclusive of spring power, closing speed, latching speed and back-check, valve screws to achieve backcheck (4040, 4040XP series) at the time of installation.
- .8 Adjust delayed action door closers to forty (40) second delay for barrier free accessibility and movement of materials. Time period to be approved by Owner.
- .9 Install head seal weatherstrip prior to installation of soffit mounted hardware. Trim cut and notch thresholds and saddles neatly to minimally fit the profile of the door frame. Install thresholds and saddles in a bed of caulking completely sealing the underside from water and air penetration.
- .10 Counter sink through bolt of door pull under push plate during installation.
- .11 Install blocking material in cavities of metal and wood stud walls and partitions. Located concave and convex type door bumpers at the appropriate height to properly contact protruding door trim.

3.3 FIELD QUALITY CONTROL

- .1 Verify each door leaf opens closes and latches. Inspect fire rated openings to ensure they are installed in compliance with NFPA 80 requirements. Test access

control system and electrified hardware devices for proper operation with owner to sign off on verification of operation. Verify electric door release hardware operates to close the door upon activation of the fire alarm system.

- .2 Perform bi-monthly on-site inspections during hardware installation and provide inspection reports listing progress of work, unacceptable work and corrective measures. Repair or replace as directed by the Consultant.
- .3 Before completion of the work but after the hardware has been installed, submit a certificate to the Consultant stating that final inspection has been made and that hardware has been checked for installation and operation by a technician from the manufacturer and hardware consultant

3.4 ADJUSTING AND CLEANING

- .1 Check and make final adjustments to each operating item of hardware on each door to ensure proper operation and function.
- .2 Adjust doors with self-closing devices or automatic closing devices for operation after the HVAC system is balanced and adjusted. Adjust spring power of non sized door closers to close and latch the door.
- .3 Hardware to be left clean and free of disfigurements.
- .4 Instruct owner personnel in the operation, adjustment and maintenance of hardware.
- .5 Check locked doors against approved keying schedule.

3.5 PROTECTION

- .1 Protect hardware from damage during construction. Wrap locks, panic hardware, and fire exit hardware, door pull trim with kraft paper or plastic bubble materials to protect finish from damage until date of substantial completion. Remove and reinstall or where necessary, use temporary hardware to maintain finish in new condition and maintain manufacturer's warranty.

3.6 HARDWARE GROUPS

FIFA East VSTS Centennial Park

Door#	HwSet#
D01A✓	01
D01B✓	01
D02✓	02
D04✓	03
D05	04
D06✓	05
D07A✓	06
D07B	07
D08✓	08
D09A✓	09
D09B✓	10
D10	11
D11✓	09
D12A✓	12
D12B✓	12
D13A✓	12
D13B✓	12
D14A✓	13
D14B✓	13
D14R	14
D15A✓	12
D15B✓	12
D16A✓	08
D16B✓	13
D17A✓	08
D17B✓	13
D18A✓	15
D18B	16
D19✓	17
D20	04
D21✓	18
D22✓	19
D23✓	20
D23A✓	21
D23B✓	22
D23C✓	23
D23D✓	24
D23E	25
D23F	25
D23G	25
D23H	25
D24✓	26
D25✓	05
D26✓	09
D27✓	09

Door#	HwSet#
D27B	25
D27C	25
D27D	25

FIFA East VSTS Centennial Park



















Hardware Group No. 01

For use on Door #(s):

D01A

D01B

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	112XY EPT		628	IVE
2	EA	POWER TRANSFER	EPT10 CON		✂ SP28	VON
1	EA	ELEC PANIC HARDWARE	HD-LX-RX-QEL-3549A-EO-4'- CON 24 VDC		✂ 626	VON
1	EA	ELEC PANIC HARDWARE	HD-LX-RX-QEL-3549A-NL-OP-4'- 388-CON 24 VDC		✂ 626	VON
1	EA	RIM CYLINDER	20-057 ICX		626	SCH
1	EA	MORTISE CYLINDER	20-061 ICX		622	SCH
2	EA	PERMANENT CORE	BY OWNER			UNK
2	EA	45 DEGREE OFFSET PULL	8145EZHD 12" O		630	IVE
1	EA	OH STOP	100S		630	GLY
1	EA	OH STOP	100S ADJ		630	GLY
1	EA	SURFACE CLOSER	4021		689	LCN
1	EA	DOOR OPERATOR	M-FORCE		✂ AN	STA
1	EA	MOUNTING PLATE	4020-18		689	LCN
1	EA	WEATHER RING 6" DIA	8310-802		✂ PLA	LCN
2	EA	ACTUATOR, WALL MOUNT 6" DIA	8310-852T		630	LCN
2	EA	ESCUTCHEON	8310-876		✂ 689	LCN
1	EA	PERIMETER SEAL	BY ALUMINUM DOOR SUPPLIER			
1	EA	THRESHOLD	CT__ x FROST INSERT x CT__ X REQ. WIDTH/DEPTH TO MATCH FRAME PROFILE / SITE CONDITIONS		719	KNC
2	EA	DOOR SWEEP	8192AA X DR WIDTH		AA	ZER
2	EA	WIRE HARNESS	CON-____(SIZE TO SUIT)		✂	SCH
2	EA	WIRE HARNESS	CON-6W		✂	SCH
1	EA	KEY SWITCH	653-1414 L2 12/24 VDC		✂ 630	SCE
2	EA	DOOR CONTACT	679-05HM		BLK	SCE
1	EA	POWER SUPPLY	PS904 900-4RL 120/240 VAC		✂ LGR	SCE

NOTE: KEYSWITCH USED TO RETRACT ELECTRIC LATCH

















FIFA East VSTS Centennial Park

Hardware Group No. 02

For use on Door #(s):

D02

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	112XY EPT		628	IVE
2	EA	POWER TRANSFER	EPT10 CON		✂ SP28	VON
1	EA	ELEC PANIC HARDWARE	HD-LX-RX-QEL-3549A-EO-4'- CON 24 VDC		✂ 626	VON
1	EA	ELEC PANIC HARDWARE	HD-LX-RX-QEL-3549A-NL-OP-4'- 388 24 VDC		✂ 626	VON
1	EA	RIM CYLINDER	20-057 ICX		626	SCH
2	EA	PERMANENT CORE	BY OWNER			UNK
2	EA	45 DEGREE OFFSET PULL	8145EZHD 12" O		630	IVE
1	EA	OH STOP	100S		630	GLY
1	EA	OH STOP	100S ADJ		630	GLY
1	EA	SURFACE CLOSER	4021		689	LCN
1	EA	DOOR OPERATOR	M-FORCE		✂ AN	STA
1	EA	MOUNTING PLATE	4020-18		689	LCN
1	EA	WEATHER RING 6" DIA	8310-802		✂ PLA	LCN
2	EA	ACTUATOR, WALL MOUNT 6" DIA	8310-852T		630	LCN
2	EA	ESCUTCHEON	8310-876		✂ 689	LCN
1	EA	PERIMETER SEAL	BY ALUMINUM DOOR SUPPLIER			
1	EA	THRESHOLD	CT__ x FROST INSERT x CT__ X REQ. WIDTH/DEPTH TO MATCH FRAME PROFILE / SITE CONDITIONS		719	KNC
2	EA	DOOR SWEEP	8192AA X DR WIDTH		AA	ZER
2	EA	WIRE HARNESS	CON-____(SIZE TO SUIT)		✂	SCH
2	EA	WIRE HARNESS	CON-6W		✂	SCH
1	EA	CARD READER	BY DIV 28		✂	UNK
2	EA	DOOR CONTACT	679-05HM		BLK	SCE
1	EA	POWER SUPPLY	PS904 900-4RL 120/240 VAC		✂ LGR	SCE

DOOR ALWAYS LOCKED. ENTRY GAINED BY ENTERING CARD OR BY MECHANICAL KEY
OVERRIDE. FREE EGRESS ALWAYS.
















FIFA East VSTS Centennial Park

Hardware Group No. 03

For use on Door #(s):

D04

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	112XY EPT		628	IVE
1	EA	POWER TRANSFER	EPT10 CON		✂ SP28	VON
1	EA	ELEC PANIC HARDWARE	HD-LX-RX-QEL-35A-NL-OP-4'-388 24 VDC		✂ 626	VON
1	EA	RIM CYLINDER	20-057 ICX		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	45 DEGREE OFFSET PULL	8145EZHD 12" O		630	IVE
1	EA	OH STOP	100S ADJ		630	GLY
1	EA	DOOR OPERATOR	M-FORCE		✂ AN	STA
1	EA	WEATHER RING 6" DIA	8310-802		✂ PLA	LCN
1	EA	36" LONG ACTUATOR	8310-836T		✂ 630	LCN
1	EA	ACTUATOR, WALL MOUNT 6" DIA	8310-852T		630	LCN
1	EA	ESCUTCHEON	8310-876		✂ 689	LCN
1	EA	PERIMETER SEAL	BY ALUMINUM DOOR SUPPLIER			
1	EA	DOOR SWEEP	8192AA X DR WIDTH		AA	ZER
1	EA	THRESHOLD	625A X OPENING WIDTH		A	ZER
1	EA	WIRE HARNESS	CON-____(SIZE TO SUIT)		✂	SCH
1	EA	WIRE HARNESS	CON-6W		✂	SCH
1	EA	CARD READER	BY DIV 28		✂	UNK
1	EA	DOOR CONTACT	679-05HM		BLK	SCE
1	EA	POWER SUPPLY	PS902 900-4RL-FA 120/240 VAC		✂ LGR	SCE







Hardware Group No. 04

For use on Door #(s):

D05

D20

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	ND80TD SPA		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	SURFACE CLOSER	1461 STD REG		689	LCN
1	EA	KICK PLATE	8400 205MM X LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CVX		630	IVE
1	EA	SOUND/SMOKE SEAL, SET	188SWH PSA (1XW, 2XH)		WH	ZER








FIFA East VSTS Centennial Park

Hardware Group No. 05

For use on Door #(s):

D06 D25

Provide each SGL door(s) with the following:









QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 5 X 4.5		652	IVE
1	EA	CLASSROOM LOCK	ND70TD SPA		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	ELECTRIC STRIKE	6211 FSE CON 12/16/24/28 VAC/VDC	 ⚡	630	VON
1	EA	DOOR OPERATOR	MAGIC ACCESS	 ⚡	AN	STA
2	EA	36" LONG ACTUATOR	8310-836T	 ⚡	630	LCN
1	EA	KICK PLATE	8400 205MM X LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CVX		630	IVE
1	EA	WIRE HARNESS	CON-6W	⚡		SCH

Hardware Group No. 06

For use on Door #(s):

D07A

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 5 X 4.5		652	IVE
1	EA	CLASSROOM LOCK	ND70TD SPA		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	ELECTRIC STRIKE	6211 FSE CON 12/16/24/28 VAC/VDC	 ⚡	630	VON
1	EA	OH STOP	100S ADJ		630	GLY
1	EA	DOOR OPERATOR	MAGIC ACCESS	 ⚡	AN	STA
2	EA	36" LONG ACTUATOR	8310-836T	 ⚡	630	LCN
1	EA	MOP PLATE	8400 205MM X SIZE TO SUIT B- CS		630	IVE
1	EA	KICK PLATE	8400 205MM X LDW B-CS		630	IVE
1	EA	WIRE HARNESS	CON-6W	⚡		SCH










FIFA East VSTS Centennial Park

Hardware Group No. 07

For use on Door #(s):

D07B

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1 4.5 X 4 NRP		630	IVE
1	EA	AUTO FLUSH BOLT	FB31P		630	IVE
1	EA	DUST PROOF STRIKE	DP2		626	IVE
1	EA	STOREROOM LOCK	ND80TD SPA 14-042		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	COORDINATOR	COR X FL		628	IVE
2	EA	MOUNTING BRACKET	MB1/MB2		689	IVE
2	EA	SURFACE CLOSER	1461 CUSH		689	LCN
1	EA	SOUND/SMOKE SEAL, SET	188SWH PSA (1XW, 2XH)		WH	ZER
2	EA	MEETING STILE	383AA X DR HT		AA	ZER

Hardware Group No. 08









For use on Door #(s):

D08

D16A

D17A

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 5 X 4.5		652	IVE
1	EA	DEADBOLT MONITOR STRIKE	MS-12		✂ 626	SDC
1	EA	CLASSROOM DEADBOLT W/ OUTSIDE INDICATOR	B663T 12-631 OS-OCC		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	DOOR PULL, 1" ROUND	PR 8103EZHD 8" N		630-316	IVE
1	EA	DOOR OPERATOR	MAGIC ACCESS		✂ AN	STA
2	EA	36" LONG ACTUATOR	8310-836T		✂ 630	LCN
1	EA	MOP PLATE	8400 205MM X SIZE TO SUIT B-CS		630	IVE
1	EA	ARMOR PLATE	8400/8402(UL RATED) 8400 865MM X SIZE TO SUIT B-CS		630	IVE
1	EA	WALL STOP	WS406/407CVX		630	IVE

NOTE: WHEN DOOR IS LOCKED MONITOR STRIKE USED TO SHUNT ACTUATORS
















FIFA East VSTS Centennial Park

Hardware Group No. 09

For use on Door #(s):

D09A D11 D26 D27

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	ND80TD SPA		626	SCH
1	EA	INTERFACE BOX	JB7		GRAY	VON
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	ELECTRIC STRIKE	6211 FS CON 12/16/24/28 VAC/VDC	 ⚡	630	VON
1	EA	DOOR OPERATOR	MAGIC ACCESS	 ⚡	AN	STA
2	EA	36" LONG ACTUATOR	8310-836T	 ⚡	630	LCN
1	EA	PUSH TO LOCK BUTTON	CM-AF550R	 ⚡	630	CAM
1	EA	MOP PLATE	8400 205MM X SIZE TO SUIT B- CS		630	IVE
1	EA	KICK PLATE	8400 205MM X LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CVX		630	IVE
1	EA	DOOR BOTTOM(MORTISE)	355AA X DR WIDTH		AA	ZER
1	EA	WIRE HARNESS	CON-6W		⚡	SCH
1	EA	EMERGENCY CALL KIT	CX-WEC10K2	 ⚡		CAM
1	EA	DOOR CONTACT	679-05HM		BLK	SCE
1	EA	ADVANCED LOGIC RELAY	CX-33	 ⚡		CAM
1	EA	POWER SUPPLY	PS902 120/240 VAC	 ⚡	LGR	SCE


















FIFA East VSTS Centennial Park

Hardware Group No. 10

For use on Door #(s):

D09B

Provide each SGL door(s) with the following:





QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	112XY X DR HT		628	IVE
1	EA	VANDL STOREROOM LOCK	ND96TD SPA		626	SCH
1	EA	INTERFACE BOX	JB7		GRAY	VON
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	ELECTRIC STRIKE	6211AL FS CON 12/16/24/28 VAC/VDC	 ⚡	630	VON
1	EA	OH STOP	100S ADJ		630	GLY
1	EA	DOOR OPERATOR	MAGIC ACCESS	 ⚡	AN	STA
1	EA	WEATHER RING 6" DIA	8310-802	 ⚡	PLA	LCN
1	EA	36" LONG ACTUATOR	8310-836T	 ⚡	630	LCN
1	EA	ACTUATOR, WALL MOUNT 6" DIA	8310-852T		630	LCN
1	EA	ESCUTCHEON	8310-876	 ⚡	689	LCN
1	EA	PUSH TO LOCK BUTTON	CM-AF550R	 ⚡	630	CAM
1	EA	PERIMETER SEAL	BY ALUMINUM DOOR SUPPLIER			
1	EA	THRESHOLD	CT__ x FROST INSERT x CT__ X REQ. WIDTH/DEPTH TO MATCH FRAME PROFILE / SITE CONDITIONS		719	KNC
1	EA	DOOR SWEEP	8192AA X DR WIDTH		AA	ZER
1	EA	WIRE HARNESS	CON-6W	⚡		SCH
1	EA	EMERGENCY CALL KIT	CX-WEC10K2	 ⚡		CAM
1	EA	DOOR CONTACT	679-05HM		BLK	SCE
1	EA	ADVANCED LOGIC RELAY	CX-33	 ⚡		CAM
1	EA	POWER SUPPLY	PS902 900-2RS-FA 120/240 VAC	 ⚡	LGR	SCE
1	EA	MULTI-FUNCTION RELAY	CX-EMF-2	 ⚡		CAM

Hardware Group No. 11

For use on Door #(s):

D10

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 5 X 4.5		652	IVE
1	EA	HOSPITAL PRIVACY W/ OUTSIDE INDICATOR	ND44S SPA OS-OCC		626	SCH
1	EA	KICK PLATE	8400 205MM X LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		626	IVE

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Hardware Group No. 12

For use on Door #(s):

D12A

D12B









D13A

D13B

D15A

D15B

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 5 X 4.5		652	IVE
1	EA	DEADBOLT MONITOR STRIKE	MS-12		✂ 626	SDC
1	EA	CLASSROOM DEADBOLT W/ OUTSIDE INDICATOR	B663T 12-631 OS-OCC		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	DOOR PULL, 1" ROUND	PR 8103EZHD 8" N		630-316	IVE
1	EA	OH STOP	100S ADJ		630	GLY
1	EA	DOOR OPERATOR	MAGIC ACCESS		✂ AN	STA
2	EA	36" LONG ACTUATOR	8310-836T		✂ 630	LCN
1	EA	MOP PLATE	8400 205MM X SIZE TO SUIT B-CS		630	IVE
1	EA	KICK PLATE	8400 205MM X LDW B-CS		630	IVE

NOTE: WHEN DOOR IS LOCKED MONITOR STRIKE USED TO SHUNT ACTUATORS












FIFA East VSTS Centennial Park

Hardware Group No. 13

For use on Door #(s):

D14A D14B D16B D17B

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	112XY X DR HT		628	IVE
1	EA	DEADBOLT	TD1850		628	TAH
1	EA	MORTISE CYLINDER	20-062 ICX		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	PUSH/PULL BAR	9145EZHD-12"-NO		630-316	IVE
1	EA	THUMBTURN	TT1025		628	TAH
1	EA	OH STOP	100S ADJ		630	GLY
1	EA	DOOR OPERATOR	M-FORCE	 ⚡	AN	STA
1	EA	WEATHER RING 6" DIA	8310-802	 ⚡	PLA	LCN
1	EA	36" LONG ACTUATOR	8310-836T	 ⚡	630	LCN
1	EA	ACTUATOR, WALL MOUNT 6" DIA	8310-852T		630	LCN
1	EA	ESCUTCHEON	8310-876	 ⚡	689	LCN
1	EA	PERIMETER SEAL	BY ALUMINUM DOOR SUPPLIER			
1	EA	THRESHOLD	CT__ x FROST INSERT x CT__ X REQ. WIDTH/DEPTH TO MATCH FRAME PROFILE / SITE CONDITIONS		719	KNC
1	EA	DOOR SWEEP	8192AA X DR WIDTH		AA	ZER
1	EA	DOOR CONTACT	679-05HM		BLK	SCE






DOOR ALWAYS LOCKED. ENTRY GAINED BY ENTERING CARD OR BY MECHANICAL KEY OVERRIDE. FREE EGRESS ALWAYS.

Hardware Group No. 14

For use on Door #(s):

D14R

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	ND80TD SPA		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	SURFACE CLOSER	4040XP DEL REG		689	LCN
1	EA	KICK PLATE	8400 205MM X LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS439		630	IVE









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Hardware Group No. 15

For use on Door #(s):

D18A

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 5 X 4.5 NRP		652	IVE
1	EA	STOREROOM LOCK	ND80TD SPA		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	ELECTRIC STRIKE	6211 FSE DS CON 12/16/24/28 VAC/VDC (DS SWITCH USED FOR REX)	 ⚡	630	VON
1	EA	DOOR OPERATOR	MAGIC ACCESS	 ⚡	AN	STA
2	EA	36" LONG ACTUATOR	8310-836T	 ⚡	630	LCN
1	EA	KICK PLATE	8400 205MM X LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CVX		630	IVE
1	EA	WIRE HARNESS	CON-6W	⚡		SCH
1	EA	INTERFACE RELAY	CX-12	⚡		CAM
1	EA	CARD READER	BY DIV 28	⚡		UNK
1	EA	DOOR CONTACT	679-05HM		BLK	SCE







DOOR ALWAYS LOCKED. ENTRY GAINED BY USING VALID CARD OR MECHANICAL KEY
OVERRIDE. FREE EGRESS ALWAYS.

Hardware Group No. 16

For use on Door #(s):

D18B

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 5 X 4.5 NRP		652	IVE
1	EA	STOREROOM LOCK	ND80TD SPA		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	SURFACE CLOSER	1461 EDA		689	LCN
1	EA	KICK PLATE	8400 205MM X LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CVX		630	IVE
1	EA	SOUND/SMOKE SEAL, SET	188SWH PSA (1XW, 2XH)		WH	ZER









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Hardware Group No. 17

For use on Door #(s):

D19

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	ND80TD SPA		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	ELECTRIC STRIKE	6211 FSE DS CON 12/16/24/28 VAC/VDC (DS SWITCH USED FOR REX)	 ⚡	630	VON
1	EA	SURFACE CLOSER	1461 STD REG		689	LCN
1	EA	KICK PLATE	8400 205MM X LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CVX		630	IVE
1	EA	SOUND/SMOKE SEAL, SET	188SWH PSA (1XW, 2XH)		WH	ZER
1	EA	WIRE HARNESS	CON-6W	⚡		SCH
1	EA	INTERFACE RELAY	CX-12	⚡		CAM
1	EA	CARD READER	BY DIV 28	⚡		UNK
1	EA	DOOR CONTACT	679-05HM		BLK	SCE










DOOR ALWAYS LOCKED FROM PULL SIDE. ENTRY GAINED BY USING VALID CARD OR MECHANICAL KEY OVERRIDE. FREE EGRESS ALWAYS.

Hardware Group No. 18

For use on Door #(s):

D21

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	ND80TD SPA		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	ELECTRIC STRIKE	6211 FSE DS CON 12/16/24/28 VAC/VDC (DS SWITCH USED FOR REX)	 ⚡	630	VON
1	EA	OH STOP	90S		630	GLY
1	EA	SURFACE CLOSER	1461 STD REG		689	LCN
1	EA	KICK PLATE	8400 205MM X LDW B-CS		630	IVE
1	EA	SOUND/SMOKE SEAL, SET	188SWH PSA (1XW, 2XH)		WH	ZER
1	EA	WIRE HARNESS	CON-6W	⚡		SCH
1	EA	CARD READER	BY DIV 28	⚡		UNK
1	EA	DOOR CONTACT	679-05HM		BLK	SCE
1	EA	POWER SUPPLY	PS902 120/240 VAC	 ⚡	LGR	SCE

DOOR ALWAYS LOCKED FROM PULL SIDE. ENTRY GAINED BY USING VALID CARD OR MECHANICAL KEY OVERRIDE. FREE EGRESS ALWAYS.











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Hardware Group No. 19

For use on Door #(s):

D22

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	112XY X DR HT		628	IVE
1	EA	DEADLATCH	TL4510		628	TAH
1	EA	MORTISE CYLINDER	20-062 ICX		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	ELECTRIC STRIKE	6211AL FSE DS CON 12/16/24/28 VAC/VDC (DS SWITCH USED FOR REX)	 ⚡	630	VON
1	EA	PUSH/PULL BAR	9145EZHD-12"-NO		630- 316	IVE
1	EA	PADDLE HANDLE	TP4590		628	TAH
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4021		689	LCN
1	EA	MOUNTING PLATE	4020-18		689	LCN
1	EA	PERIMETER SEAL	BY ALUMINUM DOOR SUPPLIER			
1	EA	DOOR SWEEP	8192AA X DR WIDTH		AA	ZER
1	EA	THRESHOLD	625A X OPENING WIDTH		A	ZER
1	EA	WIRE HARNESS	CON-____(SIZE TO SUIT)		⚡	SCH
1	EA	WIRE HARNESS	CON-6W		⚡	SCH
1	EA	CARD READER	BY DIV 28		⚡	UNK
1	EA	DOOR CONTACT	679-05HM		BLK	SCE
1	EA	POWER SUPPLY	PS902 120/240 VAC	 ⚡	LGR	SCE
















FIFA East VSTS Centennial Park

Hardware Group No. 20

For use on Door #(s):

D23

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	112XY X DR HT		628	IVE
1	EA	CONT. HINGE	112XY EPT		628	IVE
1	EA	POWER TRANSFER	EPT10 CON		✂ SP28	VON
2	EA	FLUSH BOLTS	BY ALUMINUM DOOR SUPPLIER			
1	EA	DUST PROOF STRIKE	DP2		626	IVE
1	EA	DEADLATCH	TL4510		628	TAH
1	EA	MORTISE CYLINDER	26-098 ICX X K510-711 36-083		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	ELECTRIC STRIKE	6224AL FSE 12/16/24/28 VAC/VDC		✂ 630	VON
2	EA	PUSH/PULL BAR	9145EZHD-12"-NO		630- 316	IVE
1	EA	PADDLE HANDLE	TP4590		628	TAH
1	EA	OH STOP	100S		630	GLY
1	EA	OH STOP	100S ADJ		630	GLY
1	EA	SURFACE CLOSER	4021		689	LCN
1	EA	DOOR OPERATOR	MAGIC ACCESS		✂ AN	STA
1	EA	MOUNTING PLATE	4020-18		689	LCN
1	EA	36" LONG ACTUATOR	8310-836T		✂ 630	LCN
1	EA	ACTUATOR, WALL MOUNT 6" DIA	8310-852T		630	LCN
1	EA	ESCUTCHEON	8310-876		✂ 689	LCN
1	EA	WIRE HARNESS	CON-____(SIZE TO SUIT)		✂	SCH
1	EA	WIRE HARNESS	CON-6W		✂	SCH
1	EA	CARD READER	BY DIV 28		✂	UNK
2	EA	DOOR CONTACT	679-05HM		BLK	SCE

DOOR ALWAYS LOCKED. ENTRY GAINED BY ENTERING CARD OR BY MECHANICAL KEY
OVERRIDE. FREE EGRESS ALWAYS.


















FIFA East VSTS Centennial Park

Hardware Group No. 21

For use on Door #(s):

D23A

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	112XY X DR HT		628	IVE
1	EA	CONT. HINGE	112XY EPT		628	IVE
1	EA	POWER TRANSFER	EPT10 CON	 ⚡	SP28	VON
2	EA	FLUSH BOLTS	BY ALUMINUM DOOR SUPPLIER			
1	EA	DUST PROOF STRIKE	DP2		626	IVE
1	EA	DEADLATCH	TL4510		628	TAH
1	EA	MORTISE CYLINDER	26-098 ICX X K510-711 36-083		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	ELECTRIC STRIKE	6224AL FSE 12/16/24/28 VAC/VDC	 ⚡	630	VON
2	EA	PUSH/PULL BAR	9145EZHD-12"-NO		630- 316	IVE
1	EA	THUMBTURN	TT1025		628	TAH
1	EA	OH STOP	100S		630	GLY
1	EA	OH STOP	100S ADJ		630	GLY
1	EA	SURFACE CLOSER	4021		689	LCN
1	EA	DOOR OPERATOR	M-FORCE	 ⚡	AN	STA
1	EA	MOUNTING PLATE	4020-18		689	LCN
1	EA	WEATHER RING 6" DIA	8310-802	 ⚡	PLA	LCN
1	EA	36" LONG ACTUATOR	8310-836T	 ⚡	630	LCN
1	EA	ACTUATOR, WALL MOUNT 6" DIA	8310-852T		630	LCN
1	EA	ESCUTCHEON	8310-876	 ⚡	689	LCN
1	EA	PERIMETER SEAL	BY ALUMINUM DOOR SUPPLIER			
1	EA	THRESHOLD	CT__ x FROST INSERT x CT__ X REQ. WIDTH/DEPTH TO MATCH FRAME PROFILE / SITE CONDITIONS		719	KNC
2	EA	DOOR SWEEP	8192AA X DR WIDTH		AA	ZER
1	EA	WIRE HARNESS	CON-____(SIZE TO SUIT)	⚡		SCH
1	EA	WIRE HARNESS	CON-6W	⚡		SCH
1	EA	CARD READER	BY DIV 28	⚡		UNK
2	EA	DOOR CONTACT	679-05HM		BLK	SCE

DOOR ALWAYS LOCKED. ENTRY GAINED BY ENTERING CARD OR BY MECHANICAL KEY
OVERRIDE. FREE EGRESS ALWAYS.

















FIFA East VSTS Centennial Park

Hardware Group No. 22

For use on Door #(s):

D23B

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONT. HINGE	112XY X DR HT		628	IVE
1	EA	CONT. HINGE	112XY EPT		628	IVE
1	EA	POWER TRANSFER	EPT10 CON	 ⚡	SP28	VON
2	EA	FLUSH BOLTS	BY ALUMINUM DOOR SUPPLIER			
1	EA	DUST PROOF STRIKE	DP2		626	IVE
1	EA	DEADBOLT	TD1850		628	TAH
1	EA	MORTISE CYLINDER	26-098 ICX X K510-711 36-083		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
2	EA	PUSH/PULL BAR	9145EZHD-12"-NO		630- 316	IVE
1	EA	THUMBTURN	TT1025		628	TAH
1	EA	OH STOP	100S		630	GLY
1	EA	OH STOP	100S ADJ		630	GLY
1	EA	SURFACE CLOSER	4021		689	LCN
1	EA	DOOR OPERATOR	M-FORCE	 ⚡	AN	STA
1	EA	MOUNTING PLATE	4020-18		689	LCN
1	EA	WEATHER RING 6" DIA	8310-802	 ⚡	PLA	LCN
1	EA	36" LONG ACTUATOR	8310-836T	 ⚡	630	LCN
1	EA	ACTUATOR, WALL MOUNT 6" DIA	8310-852T		630	LCN
1	EA	ESCUTCHEON	8310-876	 ⚡	689	LCN
1	EA	PERIMETER SEAL	BY ALUMINUM DOOR SUPPLIER			
1	EA	THRESHOLD	CT__ x FROST INSERT x CT__ X REQ. WIDTH/DEPTH TO MATCH FRAME PROFILE / SITE CONDITIONS		719	KNC
2	EA	DOOR SWEEP	8192AA X DR WIDTH		AA	ZER
2	EA	DOOR CONTACT	679-05HM		BLK	SCE

DOOR ALWAYS LOCKED. ENTRY GAINED BY ENTERING CARD OR BY MECHANICAL KEY
OVERRIDE. FREE EGRESS ALWAYS.




















FIFA East VSTS Centennial Park

Hardware Group No. 23

For use on Door #(s):

D23C

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	112XY EPT		628	IVE
2	EA	POWER TRANSFER	EPT10 CON		✂ SP28	VON
1	EA	PANIC HARDWARE	3549A-EO-4'		626	VON
1	EA	ELEC PANIC HARDWARE	HD-LX-RX-QEL-3549A-EO-4'- CON 24 VDC		✂ 626	VON
1	EA	ELEC PANIC HARDWARE	HD-LX-RX-QEL-3549A-NL-OP-4'- 388-CON 24 VDC		✂ 626	VON
1	EA	RIM CYLINDER	20-057 ICX		626	SCH
1	EA	MORTISE CYLINDER	20-061 ICX		622	SCH
2	EA	PERMANENT CORE	BY OWNER			UNK
2	EA	45 DEGREE OFFSET PULL	8145EZHD 12" O		630	IVE
1	EA	OH STOP	100S		630	GLY
1	EA	OH STOP	100S ADJ		630	GLY
1	EA	SURFACE CLOSER	4021		689	LCN
1	EA	DOOR OPERATOR	M-FORCE		✂ AN	STA
1	EA	MOUNTING PLATE	4020-18		689	LCN
1	EA	WEATHER RING 6" DIA	8310-802		✂ PLA	LCN
1	EA	36" LONG ACTUATOR	8310-836T		✂ 630	LCN
1	EA	ACTUATOR, WALL MOUNT 6" DIA	8310-852T		630	LCN
1	EA	ESCUTCHEON	8310-876		✂ 689	LCN
1	EA	PERIMETER SEAL	BY ALUMINUM DOOR SUPPLIER			
1	EA	THRESHOLD	CT__ x FROST INSERT x CT__ X REQ. WIDTH/DEPTH TO MATCH FRAME PROFILE / SITE CONDITIONS		719	KNC
2	EA	DOOR SWEEP	8192AA X DR WIDTH		AA	ZER
1	EA	WIRE HARNESS	CON-____(SIZE TO SUIT)		✂	SCH
1	EA	WIRE HARNESS	CON-6W		✂	SCH
1	EA	KEY SWITCH	653-1414 L2 12/24 VDC		✂ 630	SCE
2	EA	DOOR CONTACT	679-05HM		BLK	SCE

NOTE: KEYSWITCH USED TO RETRACT ELECTRIC LATCH

















FIFA East VSTS Centennial Park

Hardware Group No. 24

For use on Door #(s):

D23D

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONT. HINGE	112XY EPT		628	IVE
2	EA	POWER TRANSFER	EPT10 CON		✂ SP28	VON
1	EA	ELEC PANIC HARDWARE	HD-LX-RX-QEL-3549A-EO-4'- CON 24 VDC		✂ 626	VON
1	EA	ELEC PANIC HARDWARE	HD-LX-RX-QEL-3549A-NL-OP-4'- 388-CON 24 VDC		✂ 626	VON
1	EA	RIM CYLINDER	20-057 ICX		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
2	EA	45 DEGREE OFFSET PULL	8145EZHD 12" O		630	IVE
1	EA	OH STOP	100S		630	GLY
1	EA	OH STOP	100S ADJ		630	GLY
1	EA	SURFACE CLOSER	4021		689	LCN
1	EA	DOOR OPERATOR	M-FORCE		✂ AN	STA
1	EA	MOUNTING PLATE	4020-18		689	LCN
1	EA	36" LONG ACTUATOR	8310-836T		✂ 630	LCN
1	EA	ACTUATOR, WALL MOUNT 6" DIA	8310-852T		630	LCN
1	EA	ESCUTCHEON	8310-876		✂ 689	LCN
1	EA	PERIMETER SEAL	BY ALUMINUM DOOR SUPPLIER			
1	EA	THRESHOLD	CT__ x FROST INSERT x CT__ X REQ. WIDTH/DEPTH TO MATCH FRAME PROFILE / SITE CONDITIONS		719	KNC
2	EA	DOOR SWEEP	8192AA X DR WIDTH		AA	ZER
2	EA	WIRE HARNESS	CON-____(SIZE TO SUIT)		✂	SCH
2	EA	WIRE HARNESS	CON-6W		✂	SCH
1	EA	CARD READER	BY DIV 28		✂	UNK
2	EA	DOOR CONTACT	679-05HM		BLK	SCE
1	EA	POWER SUPPLY	PS904 900-4RL 120/240 VAC		✂ LGR	SCE

DOOR ALWAYS LOCKED. ENTRY GAINED BY ENTERING CARD OR BY MECHANICAL KEY
OVERRIDE. FREE EGRESS ALWAYS.

FIFA East VSTS Centennial Park

Hardware Group No. 25

For use on Door #(s):

D23E D23F D23G D23H D27B D27C
D27D

Provide each RU door(s) with the following:








QTY	DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1		HARDWARE BY DOOR SUPPLIER		

Hardware Group No. 26

For use on Door #(s):

D24

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	ND80TD SPA		626	SCH
1	EA	PERMANENT CORE	BY OWNER			UNK
1	EA	ELECTRIC STRIKE	6211 FSE DS CON 12/16/24/28 VAC/VDC (DS SWITCH USED FOR REX)	 ⚡	630	VON
1	EA	DOOR OPERATOR	MAGIC ACCESS		⚡ AN	STA
2	EA	36" LONG ACTUATOR	8310-836T	 ⚡	630	LCN
1	EA	KICK PLATE	8400 205MM X LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CVX		630	IVE
1	EA	WIRE HARNESS	CON-6W		⚡	SCH
1	EA	INTERFACE RELAY	CX-12		⚡	CAM
1	EA	CARD READER	BY DIV 28		⚡	UNK
1	EA	DOOR CONTACT	679-05HM		BLK	SCE

DOOR ALWAYS LOCKED. ENTRY GAINED BY USING VALID CARD OR MECHANICAL KEY
OVERRIDE. FREE EGRESS ALWAYS.

1 General

1.1 SECTION INCLUDES

- .1 Design, labour, Products, equipment and services necessary for gypsum board work.

1.2 REFERENCES

- .1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-coated (Galvanized) or Zincron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .2 ASTM C475, Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- .3 ASTM C645, Specification for Nonstructural Steel Framing Members.
- .4 ASTM C665, Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- .5 ASTM C754, Specification for Steel Framing Members to Receive Screw-Attached Gypsum Board.
- .6 ASTM C834, Standard Specification for Latex Sealants.
- .7 ASTM C840, Specification for Application and Finishing of Gypsum Board.
- .8 ASTM C1002, Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- .9 ASTM C1178, Specification for Glass Mat Water-Resistant Gypsum Backing Board.
- .10 ASTM C1278, Specification for Fiber-Reinforced Gypsum Panel.
- .11 ASTM C1396, Specification for Gypsum Board.
- .12 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.3 DESIGN REQUIREMENTS

- .1 Design ceiling suspension system in accordance with manufacturer's printed directions and ASTM C754.
- .2 Design ceiling system for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority.

- .3 Design hanger anchor and entire suspension system static loading not to exceed 25% of their ultimate capacity including lighting fixture dead loads.
- .4 Design suspension system to support weight of mechanical and electrical items such as air handling boots and lighting fixtures, and with adequate support to allow rotation/relocation of light fixtures.
- .5 Design subframing as necessary to accommodate, and to circumvent, conflicts and interferences where ducts or other equipment prevent the regular spacing of hangers.
- .6 Design wall framing system and reinforce as necessary to accommodate and support items attached to and supported by wall framing system.
- .7 Design wall framing system for wall assemblies with a height greater than 3000 mm and those assemblies incorporating non-standard gypsum board assemblies including, but not limited to, abuse resistant gypsum board, large format tile applications, etc.

1.4 REGULATORY REQUIREMENTS

- .1 Provide fire separations and fire protection exactly as specified in test design specification that validates the specified rating. Verify that work specified in other Sections, as a part of the entire assembly, meets applicable validating test design specification.

1.5 SUBMITTALS

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop Drawings:
 - .1 Submit Shop Drawings in accordance with Section 01 33 00 indicating:
 - .1 Wall assemblies, suspension systems, adjacent construction, elevations, sections and details, dimensions, thickness, finishes and relationship to adjacent construction.
 - .2 Framing and blocking for items being supported of wall systems.

- .3 Certifications: Submit written certification stating that suspended ceiling system is designed for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority.

1.6 QUALITY ASSURANCE

- .1 Qualifications: Execute the work of this Section by skilled, qualified, and experienced workers trained in the installation of the work of this Section.
- .2 Retain a Professional Engineer, licensed in Province of Ontario, with experience in work of comparable complexity and scope, to perform following services as part of work of this Section:
 - .1 Design of wall systems with height greater than 3000 mm and at nonstandard gypsum board assemblies including, but not limited to, assemblies incorporating abuse resistant gypsum board, large format tile applications, etc.
 - .2 Design of suspended gypsum board assemblies.
 - .3 Review, stamp, and sign Shop Drawings and design calculations.
 - .4 Conduct shop and on-site inspections, prepare and submit written inspection reports verifying that this part of Work is in accordance with Contract Documents and reviewed Shop Drawings.

1.7 SITE CONDITIONS

- .1 Do not begin work of this Section until:
 - .1 Mechanical and electrical work above the ceiling is complete.
 - .2 Substrate and ambient temperature is above 15 degrees Celsius.
 - .3 Relative humidity is below 80%.
 - .4 Ventilation is adequate to remove excess moisture.
- .2 Install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements 24 h before, during, and 24 h after installation.

1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials, including packaging materials, in accordance with Section 01 74 21 "Construction Waste Management and Disposal".

2 Products

2.1 MATERIALS

- .1 General: Provide components complying with ASTM C754 for conditions indicated. Fabricate sheet steel products from Galvanized steel sheet to ASTM A653M with Z 180 hot-dipped galvanized finish.
- .2 Anchors and Fasteners: Anchors and fastener of types suitable for the applications indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers, and with the capability to sustain, without failure and with a safety factor acceptable to the authorities having jurisdiction, the load imposed by ceiling construction and items supported by the ceiling.
- .3 Wire Ties: ASTM A641/A641M, Class 1 zinc coating, soft temper, 1.6 mm thick minimum diameter, soft annealed, galvanized steel wire.
- .4 Hanger wires:
 - .1 ASTM A641M, Class 1 zinc coating, soft temper, 4.1 mm diameter.
 - .2 Hanger Rods: Mild steel and zinc coated.
 - .3 Flat Hangers: Mild steel and zinc coated.
- .5 Channels: Cold-rolled steel, 1.5 mm (16 ga) minimum base metal (uncoated) thickness and 11 mm wide flanges. Sizes as required by loading conditions and fire resistant design requirements.
- .6 Steel framing: ASTM C754; ASTM A653/A653-M, Z275; cold rolled, galvanized steel sheet.
 - .1 Bailey Metal Products Limited
 - .2 Corus Metal Profiles
- .7 Steel studs and track runners: ASTM C645; Galvanized steel studs and runners, 32 mm wide x depth as indicated on Contract Drawings. Formed from galvanized steel sheet, thicknesses as follows:
 - .1 Studs less than 3000 mm: Minimum 0.53 mm (25 ga.).
 - .2 Studs greater than 3000 mm and non-standard assemblies: Minimum 0.91 mm (20 ga.), unless stud thickness of greater thickness is required to accommodate intended loading, spans, or conditions.

- .3 Track runners and ancillary components to match stud thickness.
- .8 Steel Furring Channels:
 - .1 Rigid: ASTM C645, hat shaped, depth of 22 mm, and minimum thickness of base (uncoated) metal of 0.45 mm (26 ga), unless otherwise indicated or required by loading conditions.
 - .2 Resilient: Manufacturer's standard product designed to reduce sound transmission, fabricated from steel sheet complying with ASTM A653M or ASTM A568M to form 13 mm deep channel of single- or double-leg configuration: asymmetric-shaped channel with face connected to a single flange by a single-slotted leg (web) or hat-shaped channel, with 38 mm wide face connected to flanges by double-slotted or expanded-metal legs (webs).
- .9 Main carrying channels: ASTM C645; Formed from galvanized steel sheet, 38 x 19 mm cold rolled, channels.
- .10 Resilient channel: ASTM C645; 0.5 mm thick galvanized metal, 57 mm wide x 12 mm deep for walls and ceiling to reduce sound transmission.
- .11 Furring channels: ASTM C645; Formed from galvanized steel sheet, 22 mm winged flange type, cold rolled.
- .12 Furring channels (hat type): ASTM C645; 0.5 mm base steel thickness, galvanized. 70 mm wide x 22 mm deep hat shaped channel.
- .13 Heavy duty furring channels: ASTM C645; 0.9 mm steel thickness, galvanized hat shaped channel with a wider and deeper size as required by manufacturers.
- .14 Corner bead, casing bead, and special shapes: Formed from 0.6 mm thick minimum, galvanized steel sheet, designed to be concealed by joint compound.
- .15 Deflection track: ASTM C 645 top runner with 50.8-mm- deep flanges, in thickness indicated for studs and in width to accommodate depth of studs.
- .16 Deflection track (fire rated): Provide 25 mm deep leg deflection track where indicated on rated walls. 'Fire Trak Shadowline' by Fire Trak Corporation or approved alternative.
- .17 Ceiling clips: Hot dip galvanized partition attachment clips, in square and reveal edge; 'PAC 15 Series' to match grid system by CGC Inc. or approved alternative.
- .18 Gaskets (acoustic partitions): Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 3.2 mm thick, in width to suit steel stud size.

- .19 Control joint strip: Roll formed from galvanized steel sheet, with a tape protected recess, 6 mm wide x 11 mm deep.
- .20 Screw fasteners: ASTM C1002 Type S; Corrosion resistant.
- .21 Concrete anchors: tie wire sleeve anchors, 'Redi-Drive Anchors' by ITW Red Head or approved alternative.
- .22 Acoustic/Fire insulation: ASTM C665, Paperless, semi-rigid, spun mineral fibre mats, of thickness as indicated on Contract Drawings, 'Sustainable Insulation, NoiseReducer' by CertainTeed, 'EcoTouch Quiet Zone Pink Fiberglas Acoustic Insulation' by Owens Corning Inc. or 'Roxul AFB' by Roxul Inc.
- .23 Sealants:
 - .1 Acoustic sealant (non-rated): Non-hardening acoustic sealant for use at nonrated assemblies, ASTM C834; Acrylic, mould resistant sealant, paintable. 'Smoke and Acoustic Sealant CP506' by Hilti or approved alternative.
 - .2 Sealant (fire-rated): Non-hardening sealant for use at fire-rated assemblies: ASTM E84; Acrylic based firestop sealant, colour: red or white as selected by Consultant. 'Flexible Firestop Sealant CP606' by Hilti or approved alternative.
 - .3 Standard sealants: In accordance with Section 07 91 00.
- .24 Primer: Where indicated by board manufacturer, provide primer as required to achieve finishes as defined in ASTM C840.
- .25 Joint reinforcing tape:
 - .1 Standard gypsum board: ASTM C475; 50 mm wide x 0.25 mm thick, perforated paper, with chamfered edges.
 - .2 Moisture resistant and tile backer boards: ASTM C475; fibreglass mat joint tape as recommended by board manufacturer to suit location.
- .26 Bonding adhesive: Type for purpose intended and as recommended and approved by manufacturer.
- .27 Joint and patching compound: ASTM C475; Asbestos-free, supplied by manufacturer of gypsum board used.
- .28 Special trim pieces: As indicated on drawings.

- .29 Fast setting patching compound: ASTM C475; Asbestos-free, Sheetrock or Durabond by CGC Inc., 'Moisture and Mold Resistant Setting Compound with M2Tech' by Certainteed Gypsum Canada or approved alternative.
- .30 Access doors: Supplied by other Sections for installation as part of the work of this Section

2.2 **GYPSUM BOARD PRODUCTS**

- .1 Abuse Resistant Panels (GB-1): ASTM C1396; 15.9 mm thick unless indicated otherwise on drawings; 'Abuse Resistant' by Certainteed Gypsum Canada, 'Sheetrock AR' by CGC Inc. or 'ToughRock' by Georgia-Pacific Canada LP.
- .2 Abuse and Fire Resistant Panels (GB-2X): ASTM C1396; 15.9 mm thick unless indicated otherwise on drawings; 'Abuse Resistant, Type X' by Certainteed Gypsum Canada, 'Sheetrock AR, Firecode X' by CGC Inc. or 'ToughRock Fireguard' by Georgia-Pacific Canada LP.
- .3 Moisture / Abuse resistant board (GB-3): 15.9MM thick of maximum practical lengths to minimize end joints, unless indicated otherwise; moisture and abuse resistant board "Fibrock Aquatough Interior Panel" by CGC Inc. or 'DensArmor Plus" by Georgia-Pacific Canada LP.
- .4 Abuse Resistant Panels (GB-4): ASTM C1396; 15.9 mm thick unless indicated otherwise on drawings; 'Abuse Resistant' by Certainteed Gypsum Canada, 'Sheetrock AR' by CGC Inc. or 'ToughRock' by Georgia-Pacific Canada LP.
- .5 Glass Faced Gypsum Tile Backer Board (GB-5): Moisture resistant gypsum core, glass mat embedded (front and back), acrylic coating faced. Complying with ASTM C1178/C1178M. Ends square cut, edges tapered. Provide 'Type X' core where required as part of a rated assembly Dens-Shield" and "Dens-Shield Fire-Guard", regular or Type X by Georgia-Pacific. "DiamondBack Glasroc", regular or type X by CertainTeed.
- .6 Exterior Sheathing (GB-6): 16 mm, Glass-Mat Water-Resistant Gypsum Board Sheathing to ASTM C1177
 - .1 Silicone treated core and fibreglass-mat face and back, face side surfaced with heat-cured copolymer water and vapour retardent coating, thickness as indicated, square ends and edges. Use Firestop Type X fire-resistant board where indicated.
 - .2 Standard of acceptance: Dens-Glass Gold by Georgia Pacific, Dens-Glass Gold Fireguard Gypsum Sheathing by Georgia Pacific. GlasRoc Exterior Sheathing by Certain Teed Canada..

2.3 TRIM ACCESSORIES

- .1 Accessories for Interior Installation: Cornerbead, edge trim, and control joints complying with ASTM C 1047 and requirements indicated below:
 - .1 Material: Formed steel sheet zinc coated by hot-dip or electrolytic process.
 - .2 Shapes as required in accordance with ASTM C1047.
 - .1 LC-bead with both face and back flanges; face flange formed to receive joint compound. Use LC-beads for edge trim, unless otherwise indicated.
 - .2 L-bead with face flange only; face flange formed to receive joint compound. Use L- bead where indicated.
 - .3 One-piece control joint formed with V-shaped slot and removable strip covering slot opening.
 - .4 Note that standard "U" bead (J-trim) is not acceptable. Use "L" bead that is concealed when taped and filled.

2.4 JOINT TREATMENT MATERIALS

- .1 General: Provide joint treatment materials complying with ASTM C475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.
- .2 Joint tape:
 - .1 For gypsum board: Paper reinforcing tape as recommended by the gypsum board manufacturer.
 - .2 For cement board: Alkali-resistant glass fibre tape as recommended by the cement board manufacturer.
- .3 Joint Compound for Gypsum Board: Factory-mixed, all-purpose compound formulated for both taping and topping compound.

2.5 MISCELLANEOUS MATERIALS

- .1 General: Provide auxiliary materials for gypsum board construction that comply with referenced standards and recommendations of gypsum board manufacturer.
- .2 Laminating Adhesive: Special adhesive or joint compound Low VOC

recommended for laminating gypsum panels.

- .3 Spot Grout: ASTM C475, setting-type joint compound recommended for spot-grouting hollow metal door frames.
- .4 Fastening Adhesive for Metal: Special adhesive Low VOC recommended for laminating gypsum panels to steel framing.
- .5 Fasteners: Steel drill screws complying with ASTM C954 for fastening gypsum board to steel members from 0.84 mm to 2.84 mm (21 ga to 12 ga) thick.
- .6 Acoustic sealant: Refer to Section 07 92 00 "Joint Sealants".

3 Execution

3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 COORDINATION

- .1 Examine the mechanical and electrical drawings and coordinate with appropriate other trades to establish openings, additional support, furring out and other special provisions required for mechanical and electrical fixtures and fittings and access hatches built into the work of this Section.
- .2 Examine the architectural drawings and coordinate with appropriate other trades to establish openings, additional support and other special provisions required for items built into or partially supported by the work of this Section.
- .3 Prior to installation of gypsum board or cement board, coordinate with all other trades responsible for wall-mounted items and verify that the required back up blocking is in place and properly located and installed.

3.3 SUSPENSION FRAMING

- .1 Install ceiling systems in accordance with reviewed Shop Drawings and manufacturer's written instructions.
- .2 Install hanger wires plumb and securely anchored to the building structural framing, independent of walls, pipes, ducts, and metal deck; install additional framing and hangers to bridge interference items.

- .3 Install hanger wires at 1200 mm maximum centres along carrying channels, not less than 25 mm, and not more than 150 mm from channel ends.
- .4 Install additional hangers at lighting fixture and ductwork locations. Do not attach hanger wires to mechanical or electrical equipment. Do not support mechanical and electrical fixtures and fitting on ceiling without the ceiling manufacturer's written acceptance.
- .5 Install main carrying channels transverse to structural framing members. Lap main carrying channels 200 mm minimum at splices and wire each end with two loops and prevent clustering or lining-up of splices.
- .6 Install furring channels at 400 mm o.c., not less than 25 mm, and not more than 150 mm from perimeter walls, at openings, at interruptions in ceiling continuity, and at change in plane. Install furring channels to a tolerance of 3 mm maximum in 3600 mm.
- .7 Install additional main carrying and furring channels to frame and to reinforce openings such as recessed lighting fixtures, access hatches, ceiling grilles, outlet boxes, ventilating outlets and similar items.

3.4 CEILING BULKHEADS

- .1 Frame for gypsum board faced vertical bulkheads within and at termination of ceilings.
- .2 Frame for complex bulkheads in accordance with the drawings.
- .3 Frame above suspended ceilings for gypsum board fire and sound stops and to form plenum areas as indicated.

3.5 STEEL STUDS AND FURRING

- .1 Install steel studs and furring in accordance with reviewed Shop Drawings and manufacturer's written instructions.
- .2 Install steel stud partitions to underside of structure unless indicated otherwise.
- .3 Install track runners at floors, ceilings, and underside of structure; align track runners accurately and secure to structure at 600 mm centres maximum.
- .4 Install double top track runner assembly to prevent the transmission of structural loads to steel studs.

- .5 Install steel studs vertically at 400 mm o.c., unless otherwise indicated, and not more than 50 mm from abutting walls, at openings, and at each side of corners. Install studs securely to track runners.
- .6 Schedule and coordinate steel framing installation with mechanical and electrical services installation.
- .7 Install full height, double studs at door and service openings, fastened together and stiffened back to the structure to prevent vibration when doors close.
- .8 Provide double studs boxed together at all openings, sill, head and jambs and at door jambs, fastened together and stiffened back to the structure to prevent vibration. At each opening exceeding 900 mm in width, double studs shall be 20 ga. extending to structure above, and adequately anchored at each end. Provide steel studs above and below openings spaced at 400 mm oc maximum. All metal stud partitions above doors and screens over 1220 mm wide shall be secured to structure over and reinforced with sway bracing to stabilize walls to prevent lateral movement.
- .9 Erect three studs at corner and intermediate intersections of partitions. Space 50 mm apart and brace together with wired 19 mm channels.
- .10 Stiffen partitions over 2440 mm high or 3000 mm long, or both, with horizontal bracing extended for full length of partitions. Provide one line of bracing in partitions. Space lines to provide equal unbraced panels. Provide bracing for portions of partitions over door openings in partitions over 3000 mm high, and bracing both above and below openings in partitions located no greater than 150 mm from top and bottom of opening, and extending two stud spaces beyond each edge of opening for both doors and windows. Wire tie or weld bracing to studs.
- .11 Frame control joints using back to back double studs at abutting structural elements, at dissimilar backup interface, at dissimilar walls and ceilings, at structural expansion and control joints, at door and other openings, and at 9000 mm maximum spacing in continuous runs. Install control joint strips and secure in place.
- .12 Install additional support framing at openings and cutouts for built-in equipment, upper cabinet support, access panels and similar items.
- .13 Attach to framing adequate steel reinforcing members or a 1.2 mm (18 ga.) steel stud mounted horizontally and notched around furring members to support the load of, and to withstand the withdrawal and shear forces imposed by, items installed upon the work of this Section. Such items include, but are not restricted to, miscellaneous metals, coat hooks, washroom accessories, handrail anchors, rub rails, grab bars, guards, wall-hung cabinets and fitments, shelving, curtain and drape tracks, miscellaneous specialties; Owner supplied equipment; and minor mechanical and

electrical work. Heavy mechanical and electrical equipment shall be self-supporting in Divisions 20, 21, 22, 23, 25, 26, 27 and 28.

- .14 Provide for support and incorporation of flush-mounted and recessed mechanical and electrical equipment and fixtures only after consultation and verification of methods with those performing the work of Divisions 20, 21, 22, 23, 25, 26, 27 and 28.
- .15 Install cross bracing in accordance with the steel stud manufacturer's recommendations.

3.6 FIRE RATED ASSEMBLIES

- .1 Install Products in fire rated assemblies in strict accordance with applicable ULC tested and approved designs.
- .2 Stiffen fire rated walls over 3.66 m high, where linear length of wall is greater than 2.44 m between perpendicular wall supports, with diagonal bracing above the ceiling extending perpendicular to wall at a 45E angle to structure above. Locate diagonal bracing at maximum 2.44 m o.c.
- .3 Where double layers of gypsum board are shown, and required for fire rating, screw first layer to studs and furring and laminate the second layer to the first using joint filler as an adhesive. Stagger joints between first and second layers.

3.7 ACOUSTICAL INSULATION

- .1 Install acoustic insulation in partitions, between steel studs, and as indicated on Contract Drawings and in accordance with the manufacturer's instructions. Fill stud cavities to full height of partitions and carefully cut and fit acoustic insulation around services and protrusions.

3.8 ACOUSTICAL SEALANT

- .1 Install acoustical sealant to acoustically insulated partitions in accordance with the manufacturer's instructions and Contract Drawings.
- .2 Install acoustical sealant under floor runner track, at partition perimeter both sides and at openings, cut-outs, and penetrations, concealed from view in the final installation.
- .3 Install firestop fill material behind fire rated acoustical sealant and provide firestop identification tag.
- .4 Smooth acoustical sealant with trowel prior to skin forming.

3.9 BUILT-IN CORNER GUARDS

- .1 Install built-in corner guards in accordance with manufacturer's written instructions level, secure and rigid.

3.10 GYPSUM BOARD

- .1 Comply with ASTM C840. Install gypsum board in accordance with reviewed Shop Drawings and manufacturer's written instructions.
- .2 Install gypsum board vertically or horizontally, whichever results in fewer end joints. Locate end joints over supporting members.
- .3 Install gypsum board in lightly butted contact at edges and ends and with 1.6 mm maximum open space between boards; do not force gypsum board into place. Do not install imperfect, damaged or damp boards.
- .4 Install gypsum board butting paired tapered edge joints, and mill-cut or field-cut end joints; do not place tapered edges against cut edges or ends.
- .5 Install vertical joints minimum 300 mm from the jamb lines of openings and stagger vertical joints over different studs on opposite sides of partitions.
- .6 Do not locate joints within 200 mm of corners or openings, except where control joints occur at jamb lines or where openings occur adjacent to corners. Where necessary, place a single vertical joint over the centre of wide openings.
- .7 Cut, drill and patch gypsum board as may be necessary to accommodate the work of other trades.
- .8 Fire Separations:
 - .1 Construct gypsum board assemblies, where located, in accordance with tested assemblies to obtain required or indicated fire rated assemblies. As a minimum fire separations shall consist of metal framing covered on both sides by fire-rated gypsum board.
 - .2 Install assemblies tightly to enclosing constructions to maintain integrity of the separations. Install casing beads at all perimeter edges.

3.11 CORNER, CASING BEADS AND TRIM

- .1 Corner reinforcing bead: Install along all external angles, erect plumb, level and with a minimum of joints. Secure with screws at 225 mm o.c. apply filler over flanges flush with nose of the bead and extending at least 75 mm onto surface of board each side of corner. When filler dries, apply a thin coat of topping cement and blend onto adjoining surfaces.

- .2 Casing bead: Install where wallboard butts against a surface having no trim concealing the juncture and where shown on drawings. Erect casing beads plumb or level, with minimum joints, and secure with screws at 300 mm o.c. apply filler over flange flush with bead and extending at least 75 mm onto surface of board. When dry, apply a thin coat of topping cement and blend onto adjoining surfaces.
- .3 Recess channels and trim: Install recess channels and special metal trim where shown. Secure to substrate. Provide casing beads full height on wallboard edges at recess channels and metal trim.

3.12 **JOINT TAPING AND FINISHING**

- .1 Install reinforcing tape and a minimum of 3 coats of joint compound over gypsum board joints, metal trim and accessories, and screw fasteners in accordance with the gypsum board manufacturer's instructions.
- .2 Fill gaps between, and any imperfections in, gypsum boards with joint compound, allow to dry, and sand smooth ready for painting.
- .3 Install finished gypsum board work smooth, seamless, plumb, true, flush, and with square, plumb, and neat corners.
- .4 Finish gypsum board in accordance with ASTM C840 to the following grades:
 - .1 Level 0: No taping, finishing, or accessories required. Use above suspended ceilings and within other concealed spaces, unless the assembly is fire rated, sound rated, sound or smoke controlled, or unless the space serves as an air plenum.
 - .2 Level 1: At joints and interior angles embed tape in joint compound. Leave surface free of excess joint compound. Tool marks and ridges are acceptable. Use above suspended ceilings and within other concealed spaces if the gypsum board assembly is fire rated, sound rated, sound or smoke controlled, or the space serves as an air plenum.
 - .3 Level 2: At joints and interior angles embed tape in joint compound with one separate coat of joint compound applied over joints, angles, fastener heads, and accessories. Use for water resistant gypsum board indicated for use as a substrate for ceramic tile.
 - .4 Level 3: At joints and interior angles embed tape in joint compound with two separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges. Use where heavy grade wall coverings are the final decoration.

- .5 Level 4: At joints and interior angles embed tape in joint compound with three separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges. Use for all locations except those indicated for other finish levels.
- .6 Level 5: At joints and interior angles embed tape in joint compound with three separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. Apply a thin skim coat of joint compound, or a material manufactured especially for this purpose, to the entire surface. Leave surface smooth and free of tool marks and ridges. Use where semi-gloss or gloss finish coatings are the final decoration.

3.13 GLASS MAT GYPSUM TILE BACKER INSTALLATION

- .1 Except in showers, install tile backer board in accordance with the manufacturer's recommendations and to the satisfaction of the ceramic tile installer.
- .2 Place temporary 6 mm spacer strips around the lips of plumbing fixtures.
- .3 Precut boards to required sizes and make necessary cutouts. Fit ends and edges closely but not tightly.
- .4 Start by installing the boards adjacent to the spacer strips.
- .5 Stagger end joints in successive courses.
- .6 Fasten boards to steel studs and/or steel furring spaced at maximum 400 mm o.c. and to bottom plates with 32 mm steel screws at 200 mm o.c. with perimeter fasteners between 10 mm and 16 mm from the edges of the boards.
- .7 Prefill panel joints, and joints where panels abut other surfaces such as gypsum board, with tile setting mortar or adhesive and then immediately embed joint tape and level the joints. Coordinate with the ceramic tile installer to ensure compatibility of joint treatment material.
- .8 On portions of wall not to be tiled, apply tape over joints and angles and embed tape in joint compound. Trowel joint compound over the entire surface to produce a smooth surface.

3.14 GLASS MAT GYPSUM SHEATHING INSTALLATION

- .1 Install glass mat gypsum sheathing where indicated, in accordance with the manufacturer's recommendations.
- .2 Install yellow side facing out.

- .3 Lay out boards so that joints are centered on framing or furring members. Stagger end joints.
- .4 Cut boards to fit irregular shapes and to fit snugly around door and window openings. On curved surfaces, score boards if required to maintain curves.
- .5 Ensure that all edges are supported continuously. Provide additional furring if necessary.
- .6 Butt boards together in an easy fit.
- .7 Fasten in accordance with the manufacturer's recommendations for the specific application. Maximum fastener spacing: 200 mm o.c.
- .8 Locate fasteners no closer than 10 mm from the edges of the boards and drive firmly against and flush with the surface of the sheathing. Do not countersink.

3.15 ACCESSORIES

- .1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges. Secure at 150 mm o.c.
- .2 Install casing beads around perimeter of suspended ceilings.
- .3 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.

3.16 CONTROL JOINTS

- .1 Confirm locations of control joints with Consultant before installation.
- .2 Construct control joints of preformed units except where otherwise shown. At junction of partitions with bulkheads, where indicated on the drawings, use two casing beads as indicated on the drawings.
- .3 Set gypsum board facing in the preformed units or casing beads and support independently on both sides of joint.
- .4 Provide continuous dust barrier behind and across control joints.
- .5 Install control joints straight and true.
- .6 Where not otherwise indicated, locate control joints at the following locations;

verify exact locations with the Consultant before installation:

- .1 Changes in substrate construction
- .2 Maximum 5 m spacing on walls or partitions to receive ceramic, porcelain or thin brick cladding or similar.
- .3 Maximum 9 m spacing, horizontally and vertically on walls or partitions
- .4 Maximum 9 m spacing on ceilings without perimeter relief in both directions.
- .5 Maximum 15 m spacing on ceilings with perimeter relief in both directions.

3.17 ACCESS DOORS

- .1 Install access doors, supplied as part of other parts of the work, in accordance with manufacturer's written instructions. Access Doors by SECTION 10 95 00.

3.18 SITE TOLERANCES

- .1 Install metal support systems to ensure that, within a tolerance of +3 mm and -1.5 mm for plaster thickness, finish surfaces will be flat within 3 mm under a 3 m straightedge, and with no variation greater than 1.5 mm in any running 300 mm, and that surface planes shall be within 3 mm of dimensioned location.

3.19 WORK IN EXISTING AREAS

- .1 In existing areas, where existing gypsum board work has been demolished and/or damaged and repair work is required, provide new gypsum board finish.
- .2 Thoroughly prepare areas to be repaired. Provide neat, clean and straight cuts.
- .3 Finish all repair work as specified for new work.
- .4 In existing areas where existing openings are to be filled in with gypsum board, provide new gypsum board wall and ceiling construction. Ensure new board faces are flush with faces of abutting existing walls and ceilings.

3.20 REPAIR

- .1 Make good cut-outs for services and other work, fill in defective joints, holes and other depressions with joint compound.
- .2 Make good defective work, and ensure that surfaces are smooth, evenly textured and within specified tolerances to receive finish treatments.

3.21 CLEANING

- .1 Upon completion of the work of this Section, remove from the premises all surplus material, dirt and debris caused by the work of this Section and leave the installation clean.
- .2 Clean any drippage and spills of surplus setting compound from adjacent surfaces.
- .3 Make good any damage caused by the work of this Section.

END OF SECTION

- 1 General**
- 1.1 SECTION INCLUDES**
 - .1 Labour, Products, equipment and services necessary for tile work in accordance with the Contract Documents.
- 1.2 REFERENCES**
 - .1 ANSI A108/A118/A136.1, Installation of Ceramic Tile.
 - .2 ANSI A137.1, Specifications for Ceramic Tile.
 - .3 ASTM C144, Specification for Aggregate for Masonry Mortar.
 - .4 ASTM C920, Specification for Elastomeric Joint Sealants.
 - .5 CAN/CSA A3000, Cementitious Materials Compendium.
 - .6 CGSB 71-GP-22M, Organic Adhesive for Installation of Ceramic Wall Tile.
 - .7 ISO 23599, Assistive Products for Blind and Vision-Impaired Persons - Tactile Walking Surface Indicators.
 - .8 TTMAC Specification Guide 09300 Tile Installation Manual.
 - .9 TTMAC, Maintenance Guide.
- 1.3 SUBMITTALS**
 - .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations and warranties.
 - .2 Product transportation, storage, handling and installation requirements.
 - .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Tile layout, patterns, and colour arrangement.
 - .2 Perimeter conditions, junctions with dissimilar materials.
 - .3 Setting details
 - .3 Samples:
 - .1 Submit following sample panels in accordance with Section 01 33 00.
 - .1 Each colour, texture, size, and pattern of tile.
 - .2 Adhere tile samples to 400 x 400 x 12.5 mm thick cement board complete with selected grout colour in joints.
 - .4 Certificates: Submit manufacturer's certificates stating that materials supplied are in accordance with this specification.

- .5 Closeout submittals: Submit recommended maintenance instructions and listing of recommended maintenance Products for incorporation into Operations and Maintenance Manuals in accordance with Section 01 33 00.
- 1.4 **QUALITY ASSURANCE**
 - .1 Perform work of this Section by a company with proven, acceptable experience on installations of similar complexity and scope.
- 1.5 **DELIVERY, STORAGE AND HANDLING**
 - .1 Deliver materials in adequate crates or containers with manufacturer's name and product description clearly marked.
 - .2 Handle and store tiles in a manner to avoid chipping, breakage or the instruction of foreign matter. Take precautions to protect the mortar and grout admixtures from freezing or from excessive heat.
- 1.6 **SITE CONDITIONS**
 - .1 Do not install work of this Section outside of the following environmental ranges without the Consultant's and Product manufacturer's written acceptance:
 - .1 Ambient air and surface temperature: 15 degree Celsius to 45 degree Celsius.
 - .2 Precipitation: None.
 - .2 Install temporary protection and facilities to maintain the Product manufacturer's, and specified, environmental requirements for 7 Days before, during, and 7 Days after installation.
- 1.7 **MAINTENANCE**
 - .1 Submit extra tile amounting to 3% of gross area covered, allowing proportionately for each pattern and type specified and which are part of the same Production run as installed Products. Store maintenance Products as directed by the Consultant.
- 2 Products**
- 2.1 **MATERIALS**
 - .1 General: All materials under work of this Section, including but not limited to, sealants, adhesives, and sealers are to have low VOC content limits.
 - .2 Tile:
 - .1 To ANSI A137.1.
 - .2 Supply coves, caps, inside and outside corners and bullnose tile as required.
 - .3 Where unfinished tile edge is exposed, supply cap to Consultant's selection.
 - .4 Tile Types:
 - .1 Porcelain tile (POR-1): Porcelain floor tile, sized at 12" x 24". 'Chord' by Daltile approved alternative from Stone Tile International or Centura. To be selected by the Consultant from the manufacturer's full colour range in all Price Groups.

- .2 Porcelain tile (POR-2): Porcelain floor tile, sized at 1" x 1" mosaic tile. 'Keystones' by Daltile or approved alternative. To be selected by the Consultant from the manufacturer's full colour range in Price Groups 1, 2, 3 and 4.
- .3 Porcelain tile (POR-3): Porcelain floor tile, sized at 12" x 24". 'Chord' by Daltile approved alternative from Stone Tile International or Centura. To be selected by the Consultant from the manufacturer's full colour range in all Price Groups.
- .4 Ceramic tile (CT-1): 'Rainbow' ceramic tile size 4" x 16", by Centura or approved alternative from Stone Tile International or Daltie. To be selected by the Consultant from the manufacturer's full colour range in Glossy.
- .5 Ceramic tile (CT-2): 'Rainbow' ceramic tile size 4" x 16", by Centura or approved alternative from Stone Tile International or Daltie. To be selected by the Consultant from the manufacturer's full colour range in Glossy.
- .6 Ceramic tile (CT-3): 'Rainbow' ceramic tile size 3" x 6", by Centura or approved alternative from Stone Tile International or Daltie. To be selected by the Consultant from the manufacturer's full colour range in Glossy.
- .7 Porcelain Tile Base: Cove porcelain base tile to match floor porcelain tile.
- .5 Floor transitions:
 - .1 Tile to adjacent floor finish with flush condition: Schluter 'SCHIENE', anodized aluminium finish.
 - .2 Tile to adjacent floor finish at lower elevation not exceeding 13 mm (1/2"): Schluter 'RENO-U', anodized aluminium finish.
 - .3 Tile to adjacent floor finish at lower elevation exceeding 13 mm (1/2") or to finished concrete: Schluter 'RENO-RAMP/-K', anodized aluminium finish. Wall edge protection: Aluminium edge protection with trapezoid-perforated anchoring leg and an anodized finish, continuous at all exposed tile edges, depth as required to suit tile thickness. 'Jolly' by Schluter Systems or approved alternative.
- .6 POR-1 Baseboard edge protection: Aluminium edge protection with trapezoid-perforated anchoring leg and an anodized finish, continuous at all exposed tile edges, depth as required to suit tile thickness. 'Jolly' by Schluter Systems or approved alternative.

2.2 ACCESSORIES

- .1 Cement: CAN/CSA A3000, Type GU.
- .2 Sand: ASTM C144.
- .3 Water: Potable and free of minerals and other contaminants which are detrimental to mortar and grout mixes.

- .4 Polymer additive: Keralastic by Mapei Inc or approved alternative by Ardex, Flextile Ltd. or Laticrete International.
- .5 Thin-set mortar: 2 component to ANSI A108/A118/A136.1:
 - .1 'Kerabond with Keralastic Latex Additive' by Mapei Inc., 'Ardex X77 Microtec' by Ardex, '56SR/51 w/44' by Flextile Ltd., or '254/255' by Laticrete International.
 - .2 White coloured mortar shall be provided at appropriate tile types including, but not limited to; glass tile, light coloured marble, green marble and light coloured granite.
- .6 Medium bed mortar: to ANSI A118.4:
 - .1 'Ultraflex LFT' by Mapei Inc., or approved alternative by Ardex, Flextile Ltd., or Laticrete International.
 - .2 White coloured mortar shall be provided at appropriate tile types including, but not limited to; glass tile, light coloured marble, green marble and light coloured granite
- .7 Thick bed sloped topping: Factory mixed blend of portland cement and aggregates with latex admix. 'Ardex X32 Microtec' by Ardex, '226 thick bed mortar with 3701 admix' by Laticrete, or 'Topcem with Planicrete AC Admixture' by Mapei Inc.
- .8 Shower area system: Provide the following system for use at shower areas as manufactured by Laticrete or Mapei Inc.:
 - .1 Adhesive: Polymer fortified, thin-set mortar complete with antimicrobials. '254' by Laticrete or 'Ultraflex LFT' by Mapei.
 - .2 Mortar bed: Factory mixed blend of portland cement and aggregates with latex admixture '226 thick bed mortar with 3701 admixture' by Laticrete or approved alternative by Mapei.
 - .3 Waterproofing: Single component, self curing liquid rubber polymer. 'Hydro Ban' by Laticrete or 'Aquadefense' by Mapei.
 - .4 Finish: As indicated on Interior Design Schedule.
 - .5 Epoxy grout: High performance sanded epoxy grout 'SpectraLOCK Pro Grout' by Laticrete or 'Kerapoxy CQ' by Mapei in colour as selected by Consultant.
- .9 Primer: To meet specified requirements of adhesive manufacturer.
- .10 Cleaner: In accordance with TTMAC's requirements and as recommended by tile manufacturer.
- .11 Organic adhesive (walls): CGSB 71-GP-22M, Type 1.
- .12 Grout:
 - .1 Floors and bases (below 3 mm joint width): 'Keracolor U' by Mapei Inc. or approved alternative by Ardex, Flextile Ltd. or Laticrete International.
 - .2 Floors and bases (3 mm to 10 mm joint width): 'UltraColor Plus' by Mapei Inc. or approved alternative by Ardex, Flextile Ltd. or Laticrete International.

- .3 Walls (1.5 mm to 3 mm joint width): 'Keracolor U' by Mapei Inc. or approved alternative by Ardex, Flextile Ltd. or Laticrete International.
 - .4 Walls (over 3 mm joint width): 'Ultracolour Plus' by Mapei Inc. or approved alternative by Ardex, Flextile Ltd. or Laticrete International.
 - .5 Grout colour: To be selected by the Consultant from the manufacturer's full colour range.
 - .13 Tile sealant: In accordance with Section 07 91 00.
- 2.3 **MIXES**
- .1 Levelling bed mix:
 - .1 1 part Portland cement.
 - .2 4 parts sand.
 - .3 1 part water (including polymer additive), adjusted for water content of sand
 - .4 1/10 part polymer additive.
- 3 Execution
- 3.1 **EXAMINATION**
- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- 3.2 **SURFACE PREPARATION**
- .1 Clean and dry surfaces thoroughly. Remove oil, wax, grease, dust, dirt, paint, tar, primers, form release agents, curing compound, and other foreign material from substrate surfaces which may prevent or reduce adhesion.
 - .2 Neutralize any trace of strong acids or alkali from the substrate.
- 3.3 **CONTROL JOINTS**
- .1 Provide control, expansion and isolation joints in accordance with TTMAC specification 301MJ and as indicated on drawings. Install in locations indicated on drawings and specified herein.
 - .2 Continue control, construction, and cold joints in the structural substrate up through the tile finish, and align with mortar joints where possible. Review joint locations on Site with the Consultant.
 - .3 Install joint widths to match grout joint widths, except where a minimum width is indicated.
 - .4 Install control joints in the following typical locations:
 - .1 Aligned over changes in type of substrate.
 - .2 At the restraining perimeters such as walls and columns.
 - .3 Interior areas (not subject to sunlight): 6 mm minimum width, at 7320 mm o.c. maximum.

.4 Interior areas (subject to sunlight): 6 mm minimum width, at 3660 mm o.c maximum.

.5 As indicated on the Contract Drawings.

.5 Seal control joints in accordance with Section 07 91 00.

3.4 **LEVELLING BED**

.1 Install a levelling bed on uneven substrate surfaces, level and plumb substrates in accordance with the following tolerances:

.1 Vertical surfaces: 3 mm in 2.4 m maximum.

.2 Horizontal surfaces: 6 mm in 3 m from finished levels of the surface, or better.

.2 Clean structural substrate control joints and blow-clean with compressed air. Grout fill control joints flush to slab with levelling bed.

3.5 **SHOWER AREA SYSTEM**

.1 Install mortar bed over thin set adhesive on uneven substrate surfaces, level and plumb substrates in accordance with manufacturer's written instructions and having the following tolerances:

.1 Vertical surfaces: 3 mm in 2.4 m maximum.

.2 Horizontal surfaces: 6 mm in 3 m from finished levels of the surface, or better.

.2 Provide slopes to drains as indicated on drawings.

.3 Apply waterproofing with a spray applicator on prepared substrate to a total dry film thickness of 0.8 mm in accordance with manufacturer's printed directions. Carry up walls to 50 mm high.

.4 Install finish materials after site inspection by manufacturer, ensuring that materials have been installed correctly and in accordance with manufacturers written instructions. Provide written inspection report verifying manufacturers warranty of system.

.5 Apply grout for shower area system in accordance with epoxy grout manufacturer's directions to produce watertight, filled joints without voids, cracks and excess grout. Thoroughly compact and tool grout. Finish grout flush to edge thickness of tile and remove excess grout with soft burlap or sponge moistened with clean water.

3.6 **GENERAL INSTALLATION REQUIREMENTS**

.1 Install tiles in accordance with manufacturer's instructions and TTMAC Specification Guide 09300 Tile Installation Manual. Manufacturer's installation instructions govern over TTMAC Installation Manual.

.2 Lay out work to produce a symmetrical pattern with minimum amount of cutting. Ensure cut tile at room perimeter and at joints is not less than ½ full size.

.3 Install trim to be placed under tile in locations indicated on Drawings.

.4 Set tiles in place and rap or beat with a beating block as necessary to ensure a proper bond and to level surface. Align tile for uniform joints and allow to set until firm. Clean excess mortar from surface of tile with a wet cloth or sponge while mortar is fresh.

- .5 Ensure following minimum mortar contact coverage to back of tiles. Contact must be evenly distributed to give full support of the tile.
 - .1 98% for large format (305 mm x 305 mm or greater) interior applications.
 - .2 90% for non-large format interior applications.
 - .3 100% for shower applications.
 - .4 100% for exterior applications.
 - .6 Adjust joints between units uniform, plumb, straight, even, and true, with adjacent tile flush. Align grout joints in both directions unless indicated otherwise.
 - .7 Align floor, base and wall grout joints.
 - .8 Install tile accessory fittings for a complete and fully coordinated tile assembly.
 - .9 Install wall tile full height unless indicated otherwise.
 - .10 Do not place tile, trim, and accessories over control, expansion, or isolation joints. Stop materials in either side on joints and provide control, expansion and isolation joints as specified.
 - .11 Cut and fit tile neatly around piping, fittings, joints, projections and around recesses items e.g. washroom accessories. Where surface mounted equipment and accessories are installed on tile surfaces, extend tile over surfaces. Cut edges smooth, even, and free from chipping; chipped and broken edges are not acceptable.
 - .12 Do not proceed with grouting until minimum 48 hours after tile has set, to prevent displacement of tiles.
 - .13 Apply grout in accordance with grout manufacturer's directions to produce watertight, filled joints without voids, cracks and excess grout. Thoroughly compact and tool floor grout. Finish grout flush to edge thickness of tile and remove excess grout with soft burlap or sponge moistened with clean water.
- 3.7 **CLEANING**
- .1 Clean off excess grout with soft burlap or sponge moistened with clean water.
 - .2 Polish floor and wall tile after grout has cured in accordance with TTMAC recommendations in the Maintenance Guide; do not use acid for cleaning.
 - .3 Re-point joints after cleaning as required to eliminate imperfections, then re-clean as necessary. Avoid scratching tile surfaces.
- 3.8 **JOINT BACKING AND TILE SEALANT**
- .1 Install joint backing under sealant as necessary.
 - .2 Install tile sealant around piping and fittings extending through tiled surfaces.
 - .3 Seal tile control joints.
 - .4 Seal internal tile to tile junctions. Tool to a smooth, flush surface, free from air bubbles and contamination.
- 3.9 **PROTECTION**

SECTION 09 30 00

TILE

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- .1 Prevent traffic over tiled areas, and protect tiled assemblies from weather, freezing, and water immersion, for 72 hours minimum, after final installation.
- .2 Prevent direct impact, vibration and heavy hammering on adjacent and opposite walls for 24 hours minimum, after final installation.
- .3 Cover work temporarily with building paper properly lapped and taped at joints until work has been approved by Consultant.

END OF SECTION

- 1 General**
- 1.1 SECTION INCLUDES**
 - .1 Design, labour, Products, equipment and services necessary for acoustical ceilings work in accordance with the Contract Documents.
- 1.2 REFERENCES**
 - .1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM C423, Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .3 ASTM C635, Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
 - .4 ASTM C636, Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.
 - .5 ASTM C645, Specification for Non-Load Bearing (Axial) Steel Studs, Runners (Tracks), and Rigid Furring Channels for Screw Application of Gypsum Board.
 - .6 ASTM C665, Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - .7 ASTM E1264, Classification for Acoustical Ceiling Products.
- 1.3 DESIGN REQUIREMENTS**
 - .1 Design acoustical ceiling suspension system and anchors in accordance with specified Seismic Design requirements.
 - .2 Design ceiling suspension systems in accordance with ASTM C636 and manufacturer's printed directions.
 - .3 Design tile ceiling system for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority. Acoustic panel system is not designed to carry the weight of electrical equipment.
 - .4 Design hanger anchor and entire suspension system static loading not to exceed 25% of their ultimate capacity including lighting fixture dead loads.
 - .5 Design tile suspension system to support weight of mechanical and electrical items such as air handling boots and lighting fixtures, and with adequate support to allow rotation/relocation of light fixtures. Acoustic panel system is not designed to carry the weight of mechanical and electrical equipment.
 - .6 Design subframing as necessary to accommodate, to avoid conflicts and interferences where ducts or equipment prevent regular spacing of hangers.
- 1.4 SUBMITTALS**
 - .1 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Suspension system layout including hangers and supports for acoustic tile system.

- .2 Acoustic panel system including suspension system, hangers, supports and panel sizes and locations.
 - .3 Conditions at abutting, intersecting, and penetrating construction.
 - .4 Dimensioned locations of lighting fixtures, diffusers, sprinkler heads and other items that pierce the ceiling plane.
 - .2 Samples:
 - .1 Submit following samples in accordance with Section 01 33 00:
 - .1 One full-size sample of each type of tile panels to be used.
 - .2 One of each type of suspension system members.
 - .3 Certificates: Submit written certification stating that suspended ceiling system is designed for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority.
- 1.5 **QUALITY ASSURANCE**
 - .1 Mock-up:
 - .1 Construct one 3 m² mock-up for each type of ceiling system incorporating typical light fixture and other typical mechanical and electrical fixtures.
 - .2 Test the adequacy of the suspension system to support the fixtures without deflection of ceiling or failure of hanging wire anchorage. Supply copy of Test Results to Consultant.
 - .3 Change materials and installation methods if tests indicate proposed system is inadequate and re-test as necessary until system approved.
 - .4 Give early notice to Consultant and Mechanical and Electrical Trades and cooperate with them in selecting suitable location for sample ceiling and timing of installation and test.
 - .5 Do not commence general installation work until sample ceiling approved, then install ceiling to conform with approved samples.
 - .6 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.
- 1.6 **SITE CONDITIONS**
 - .1 Do not install the work of this Section until:
 - .1 Mechanical and electrical work above the ceiling is complete.
 - .2 Relative humidity is below 80 %.
 - .3 Ventilation is adequate to remove excess moisture.
 - .4 Areas are closed and protected against weather, and maintained at no less than 10°C.
 - .2 Install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements 24 h before, during, and after installation.

1.7 MAINTENANCE

- .1 Submit extra acoustic ceilings amounting to 5% of gross ceiling area, allowing proportionately for each pattern and type specified to nearest full carton. Submit Products which are part of same production run as installed Products. Store maintenance Products as directed by Consultant.

1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials, including packaging materials, in accordance with Section 01 74 21 "Construction Waste Management and Disposal".

1.9 DELIVERY, STORAGE AND HANDLING

- .1 Transport, handle and store material in manner to prevent warp, twist, damage to panel edges and surfaces in accordance with Manufacturer's recommendations.
- .2 Any warped and/or damaged panels and trim shall be rejected and be replaced by new, straight, undamaged and acceptable material at no cost to Owner.
- .3 Bent, twisted or otherwise damaged Tee grid suspension components shall not be used under any circumstances. Replace such damaged items with new undamaged material at no additional cost to Owner.
- .4 Store material in warm, dry place away from water and the elements. Protect against undue loading stresses and shock.
- .5 All packaged material shall be delivered in original manufacturers wrappers and containers with labels and seals intact. All cartons shall bear U.L. label.

2 Products

2.1 MATERIALS

- .1 Wherever possible, acoustical ceiling tiles, steel suspension system and framing used in work of this Section are to contain recycled content.
- .2 Galvanized steel sheet: ASTM A653/A653-M, Z275; cold rolled, galvanized steel sheet.
- .3 Main carrying channels: ASTM C645; Channels formed from galvanized steel sheet, 38 x 19 mm cold rolled.
- .4 Subframing: ASTM C645; Channels formed from galvanized steel sheet, dimensions and spans as required.
- .5 Hangers: 2.6 mm minimum diameter, galvanized steel wire.
- .6 Tie wire: 1.6 mm minimum diameter, soft annealed galvanized steel wire.
- .7 Concrete anchors: tie wire sleeve anchors, 'Redi-Drive Anchors' by ITW Red Head or approved alternative.
- .8 Wall mouldings and accessories, including but not limited to, corner caps, edge mouldings, panel hold over clip, metal closures, and trim. Finish and colour: same as main tees.

- .9 Exposed main, cross tees, and relocatable cross tees: ASTM C635, 38 mm high steel, bulb tee design double steel web, rectangular single spans without exceeding a deflection of 1/360 of the span. Splices to be integral and reversible; cross tee interlocking into main tee. Colour and finish: Manufacturer's standard white.
- .1 Suspension system:
 - .1 'Prelude XL 15/16" Exposed Tee Systems by Armstrong World Industries Inc.
 - .2 'DX' by CGC Inc.
 - .3 '15/16" Classic Stab System by Certainteed Ceilings Canada.
- .10 Acoustic tile (ACT-1): ASTM E1264, type 3, Form 2, Pattern CE. Wet-formed mineral fiber with factory applied vinyl latex paint. 610 (2'-0") x 1220 (4'-0") x 15 mm (5/8") thick square edge 'Dune (Fine Texture) 1773' as manufactured by Armstrong Ceiling Tiles, or approved alternative by Certainteed Ceilings Canada or CGC Inc.
- .11 Wall mouldings: To match acoustical ceiling suspension system.

3 Execution

3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 SUSPENSION SYSTEM

- .1 Coordinate locations and openings of mechanical and electrical services support, and penetration through the acoustical ceilings. Coordinate field conditions, clearances, measurements, and mechanical and electrical services testing and commissioning, above the acoustical ceilings.
- .2 Install hanger wires plumb and securely anchored to the building structural framing, independent of walls, pipes, ducts, and metal deck; install additional framing and hangers to bridge interference items.
- .3 Install acoustical ceiling systems in accordance with manufacturer's written instructions, reviewed shop drawings, and ASTM C636, listed in order of precedence.
- .4 Install hanger wires at 1200 mm maximum centres along carrying channels, not less than 25 mm, and not more than 150 mm from channel ends.
- .5 Install additional hangers at lighting fixture and air distribution ductwork locations. Do not attach hanger wires to mechanical or electrical equipment. Do not support mechanical and electrical fixtures and fitting on ceiling without the ceiling manufacturer's written acceptance.
- .6 Install acoustical ceiling suspension system to a tolerance of 1:1200 of span and 0.4 mm maximum between adjacent metal members. Tolerances are not cumulative. Refer to Electrical Contract Drawings for fixture layout.
- .7 Do not bend or twist hangers as a means of levelling. Form double loops tightly and lock to prevent vertical movement or rotation within the loop.
- .8 Install edge moulding at intersection of ceiling and vertical surfaces.

- .9 Centre acoustical ceiling suspension systems on room axis; install equal border pieces. Install hangers onto the ends of main tee runners at not more than 150 mm from ends of runners, adjacent and perpendicular to walls.
- .10 Support the suspension system independently of walls, columns, ducts, pipes and conduits.
- .11 Install main runners in maximum available lengths. Layout joints in suspension members to avoid the perimeters of recessed fixtures. Lock grid members to form a rigid assembly. Install additional tee, suspension system framing around recessed fixtures, diffusers, grilles and other items for a complete assembly.

3.3 ACOUSTIC LAY-IN TILES

- .1 Install acoustic tile in grid system openings supported by bottom flanges of members. Provide special shapes and sizes to provide a complete installation by cutting tile to fit into openings. Fit tile moderately tight between upright legs of members.
- .2 Carefully cut and trim acoustic tiles to accommodate items piercing the finished ceiling plane.
- .3 Remove and replace acoustic tiles with broken edges, or damaged, marked, discoloured, soiled, or stained faces.

3.4 ADJUSTMENTS AND CLEANING

- .1 Clean soiled or discoloured surfaces of exposed work on completion of work.
- .2 Replace components which are visibly damaged, marred or uncleanable.

END OF SECTION

1 General

1.1 SECTION INCLUDES

- .1 Labour, Products, equipment and services necessary for resilient sheet flooring
Work in accordance with the Contract Documents.

1.2 REFERENCES

- .1 ASTM D2047, Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine.
- .2 ASTM F710, Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- .3 ASTM F970, Standard Test Method for Static Load Limit.
- .4 ASTM F1516, Standard Practice for Sealing Seams of Resilient Floor Products by the Heat Weld Method.
- .5 ASTM F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
- .6 ASTM F 2170, Standard Test Method for Determining Relative Humidity in Concrete Slabs Using in-situ Probes.
- .7 ASTM F2034, Standard Specification for Sheet Linoleum Floor Covering.
- .8 CAN/ULC-S102.2-M, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.
- .9 ISO 717-2, Acoustics - Rating of Sound Insulation in Buildings and of Building Elements - Part 2: Impact Sound Insulation.

1.3 SUBMITTALS

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings: Submit shop drawings indicating seam layout and welding procedures in accordance with Section 01 33 00.
- .3 Samples:
 - .1 Submit samples in accordance with Section 01 33 00:

- .1 Submit two 250 x 200 mm samples of each type of sheet material and colour.
 - .2 Submit two 150 mm x 150 mm samples of resilient base. Flash cove base samples must be representative of riser height and toe lengths specified, and shall represent one completed inside corner and one completed outside corner, with seams sealed and finished. Produce flash cove base samples in specified flooring materials and selected colours.
 - .4 Closeout submittals: Submit maintenance and cleaning data for incorporating into Operations and Maintenance Manuals in accordance with Section 01 10 10.
- 1.4 **QUALITY ASSURANCE**
- .1 Installers qualifications (prefabricated flash cove bases): Perform Work of this Section by a company that has a minimum of five years proven experience in the installation of prefabricated flash cove bases of a similar size and nature and that is approved by manufacturer. Submit to Consultant, installer's current certificate of approval by the material manufacturer as proof of compliance.
- 1.5 **SITE CONDITIONS**
- .1 Maintain air temperature and structural base temperature at flooring installation area above 20oC for 48 hr before, during and 48 hr after installation.
 - .2 Store materials for 2 days prior to installation in area of Work to achieve temperature stability.
 - .3 Do not lay flooring in conditions of high humidity or where exposed to cold drafts. In hot weather, protect from direct sunlight.
 - .4 Provide adequate ventilation during installation.
- 1.6 **EXTENDED WARRANTY**
- .1 Manufacturer's warranty:
 - .1 Resilient flooring: Provide flooring manufacturer's warranty naming Owner as beneficiary, covering excessive wear for a period of 5 years from the date work is certified as Substantially Performed.
 - .2 Prefabricated flash cove base: Warrant prefabricated flash cove base for lifetime against defects and/or deficiencies in accordance with General Conditions of the Contract. Promptly correct any defects or deficiencies which become apparent within warranty period, to satisfaction of Consultant and at no expense to Owner. Defects include but are not limited to punctures through aluminum backing at cove radius provided prefabricated flash cove base was installed professionally in accordance with manufacturer's written specifications.
- 1.7 **MAINTENANCE**

- .1 Submit extra 5% or to nearest full roll of each colour, pattern and type of flooring material and bases required for maintenance use. Identify each roll. Store where directed. Submit maintenance material in one piece and of same production run as installed materials.
- 2 Products**
- 2.1 MATERIALS**
- .1 All materials under Work of this Section, including but not limited to, primers and adhesives are to have low VOC content limits.
- .2 Resilient Sheet Flooring (LINO-1):
 - .1 Conforming to ASTM F2034, Type 1, 2.5 mm thick, homogeneous resilient flooring, made from natural ingredients, mixed and calendared onto a natural jute backing.
 - .2 Flame spread: 150 to CAN/ULC-S102.2-M.
 - .3 Smoke developed: 160 to CAN/ULC-S102.2-M.
 - .4 Impact sound reduction: when tested to ISO 717/2, 6 dB.
 - .5 Slip resistance: Static coefficient of slip resistance meets or exceeds 0.6 when tested in accordance with ASTM D2047.
 - .6 Static load limit: 450 pounds per square inch when tested in accordance with ASTM F970.
 - .7 Acceptable products and manufacturers: 'Eternal Step' by Forbo Flooring or approved alternative.
 - .8 Colours:
 - .1 LINO-1: DLW Landscape by Gerflor. Consultant to select full range of standard colours
- .3 Welding rod: type recommended by flooring manufacturer to complement flooring.
- .4 Prefabricated integral cove base:
 - .1 Prefabricated Flash Cove Bases:
 - .1 Fabricated from same material and dye lots as resilient sheet flooring types as specified, in maximum practical lengths, with 38 mm x 38 mm formed aluminum reinforcing bonded to back of base material. Height: 100 mm high, unless otherwise indicated.
 - .2 'FlashCove Prefabricated Bases' by FlashCove Prefabricated Bases Inc. or approved alternative.

- .2 Metal end caps: Provide J-trim type metal end caps for all cove bases. For adhesive installation; stainless steel cap; 'Chiklet Cap' by FlashCove Prefabricated Bases Inc. or approved alternative.
- .5 Primers and adhesives: Low VOC, waterproof, of types recommended by flooring and base manufacturer for specific material on applicable substrate, above, on or below grade.
- .6 Accessories and wheel transition strips: PVC, conforming to NFPA 101, colour and accessory type selected by Consultant from manufacturer's full range; 'Specialty Floor Finishing Accessories' by Johnsonite. Adhesive recommended by Accessories manufacturer.
- .7 Concrete skim coat compound: High-performance, rapid-setting cement based skim coating compound. 'Ultra SkimCoat' by Mapei or approved alternative for filling minor voids and leveling existing substrate.
- .8 Stain sealer and polish: Type recommended by flooring manufacturer.

3 Execution

3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.
- .2 Ensure concrete floors meet the following minimum requirements and requirements of the flooring manufacturer. If there is a conflict between these requirements and those of the flooring manufacturer, the more stringent shall apply.
 - .1 Internal Relative Humidity Test: Perform internal relative humidity testing in accordance with ASTM F2170. Results shall not exceed 80% RH.
 - .2 Moisture Test: Moisture emissions from concrete subfloors (cured for a minimum of 28 days) must not exceed 3 lbs per 1000sf per 24 hours (1.4 kg H₂O/24 hr/93 m²) for acrylic adhesive and 5lbs for polyurethane adhesive via the Calcium Chloride Test Method (ASTM F1869).
 - .3 The pH level of the subfloor surface shall not be higher than 9.9. If higher, subfloor must be neutralized.
- .3 Ensure that sub-floors have been provided as specified without holes, protrusions, cracks, depressions or other major defects.
- .4 Ensure that control joints have been filled and levelled.
- .5 Defective Work resulting from application to unsatisfactory surfaces will be considered the responsibility of those performing the Work of this Section.

3.2 SUBFLOOR TREATMENT

- .1 Flooring shall be installed over subfloors conforming to ASTM F710 for concrete.
- .2 Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.
- .3 Apply sub-floor filler to low spots and cracks to achieve floor level to a tolerance of 1:1000, allow to cure.
- .4 Meet ASTM F710 Standard for Concrete or other monolithic floors.
- .5 Clean and remove all deleterious materials from surfaces to receive this Work in accordance with the adhesive manufacturer's recommendations.
- .6 Prime concrete to flooring manufacturer's printed instructions.

3.3 RESILIENT SHEET FLOORING APPLICATION

- .1 Install resilient sheet flooring in accordance with manufacturer's written instructions.
- .2 Apply adhesive uniformly using recommended trowel in accordance with flooring manufacturers instructions. Do not spread more adhesive that can be covered by flooring before initial set takes place.
- .3 Run sheets in direction of traffic. Double cut sheet joints and continuously seal according to manufacturer's printed instructions. Remove adhesive seepage of seams or surface while adhesive is still wet.
- .4 Heat weld seams in accordance with ASTM F1516 and manufacturer's printed instructions.
- .5 As installation progresses and after installation, roll flooring with minimum 45 kg roller to ensure full adhesion.
- .6 Cut flooring neatly around fixed objects.
- .7 Terminate flooring at centreline of door in openings where adjacent floor finish or colour is dissimilar.
- .8 Install reducing edge strips at unprotected or exposed edges where flooring terminates or where there are two finishes of different thicknesses.

3.4 PREFABRICATED FLASH COVE BASE APPLICATION

- .1 Install prefabricated flash cove base in accordance with manufacturer's written instructions.
- .2 Provide integral coved base at room perimeter and at built-in fitment locations complete with accessories as required for complete and secure installation.
- .3 Dry-fit prefabricated flash cove base; cut and fit material to required lengths. Mitre-cut inside and outside corners.
- .4 Dry-fit and cut cove cap prior to prefabricated flash cove base installation.
- .5 Scribe glue line on walls and floor at edge of prefabricated flash cove base material.

- .6 Apply adhesive in full spread (100% coverage on 2 surfaces) for full length of prefabricated flash cove base material. Apply prefabricated flash cove base to wall surface straight and level.
 - .7 Slide base cap behind prefabricated flash cove base material.
 - .8 Hand roll prefabricated flash cove base material onto wall and floor surface removing bumps, ripples and fishmouths. Remove excess adhesive.
 - .9 Heat weld seams (vertical and horizontal) in prefabricated flash cove base material.
- 3.5 **ACCESSORIES AND WHEELED TRANSITION APPLICATION**
- .1 Install accepted adaptors between different flooring materials in accordance with manufacturer's instructions.
 - .2 Ensure that adaptors have been clipped into place properly to provide a smooth, gradual transition between floors of different height.
 - .3 Install accessories in accordance with manufacturer's written instructions.
- 3.6 **CLEANING AND SEALING**
- .1 Forty-eight hours after installation, clean sheet flooring surfaces with a mild soap solution approved by finish manufacturer. Rinse clean and allow to dry.
- 3.7 **PROTECTION OF FINISHED WORK**
- .1 Protect floors and bases from time of final set of adhesive until accepted by Consultant.
 - .2 Protect prefabricated flash cove bases from scratches, gouges, scuff marks and other damage from time initial surface protection application until final inspection.
 - .3 Prohibit traffic on floor for 48 hours after installation.
 - .4 Cover cleaned surfaces with fibre reinforced, clean, non-staining clean, kraft paper. Secure in position with gummed tape to prevent drifting. Remove covering when directed by Consultant.

END OF SECTION

1 General

1.1 SECTION INCLUDES

- .1 Labour, Products, equipment and services necessary for resilient athletic flooring
Work in accordance with the Contract Documents.

1.2 REFERENCES

- .1 ASTM D412: Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.
- .2 ASTM D2047: Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as measured by the James Machine.
- .3 ASTM D2240: Standard Test Method for Rubber Property (Durometer Hardness).
- .4 ASTM D3389: Standard Test Method for Coated Fabrics Abrasion Resistance (Rotary Platform Abrader).
- .5 ASTM E648: Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.
- .6 ASTM E662: Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
- .7 ASTM E1643: Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
- .8 ASTM E1745: Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
- .9 ASTM F386: Standard Test Method for Thickness of Resilient Flooring Materials Having Flat Surfaces.
- .10 ASTM F410: Standard Test Method for Wear Layer Thickness of Resilient Floor Coverings by Optical Measurement.
- .11 ASTM F710: Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- .12 ASTM F925: Standard Test Method for Resistance to Chemicals of Resilient Flooring.
- .13 ASTM F970: Standard Test Method for Static Load Limit.
- .14 ASTM F1514: Standard Test method for Measuring Heat Stability of Resilient Flooring by Color Change.
- .15 ASTM F1515: Standard Test Method for Measuring Light Stability of Resilient Flooring by Color Change.

- .16 ASTM F1869: Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
- .17 ASTM F2170: Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
- .18 ASTM F2199: Standard Test Method for Determining Dimensional Stability of Resilient Floor Tile after Exposure to Heat.

1.3 **SUBMITTALS**

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
 - .2 Shop drawings: Submit shop drawings indicating seam layout and welding procedures in accordance with Section 01 33 00.
 - .3 Samples:
 - .1 Submit samples in accordance with Section 01 33 00:
 - .1 Submit two 250 x 200 mm samples of each type of sheet material and colour.
 - .2 Submit two 150 mm x 150 mm samples of resilient base.
 - .4 Closeout submittals: Submit maintenance and cleaning data for incorporating into Operations and Maintenance Manuals in accordance with Section 01 33 00.

1.4 **QUALITY ASSURANCE**

- .1 Manufacturer must be certified ISO 9001.
- .2 Manufactured Product must have undergone a vulcanization process; factory lamination should not be accepted as equivalent.
- .3 Manufacturer must have a minimum of fifteen (15) years of experience in the manufacturing of prefabricated resilient athletic flooring.
- .4 Installer must have performed installations of the same scale in the last three (3) years.
- .5 Installer to be recognized and approved by the Manufacturer.

1.5 **DELIVERY, STORAGE AND HANDLING**

- .1 Products Supplied must be delivered in Manufacturer's original, unopened and undamaged packaging with identification labels intact.
- .2 Products Supplied must be protected from exposure to harmful weather conditions and must be safely stored on a clean, dry, flat surface. Store rolls of resilient athletic flooring upright; store tiles of resilient athletic flooring on a flat surface, carefully protecting corners and edges.
- .3 Climate controlled storage is recommended. Storage temperature must not be below 55°F (13°C) and must not exceed 100°F (38°C).
- .4 Avoid storing Manufactured Product for extended periods of time or additional material trimming may be required.
- .5 Products Supplied need not suffer damage during handling (i.e. dents/scratches, edge chipping, excessive warping, etc.).

1.6 SITE CONDITIONS

- .1 The General Contractor or Construction Manager shall be responsible for ensuring all site conditions meet the requirements of the Manufacturer, as referenced herein at sections 3.2 and 3.3.
- .2 Concrete subfloors, on or below grade, must be installed over a permanent effective vapor retarder, respecting current versions of the standard practice ASTM E1643 and the standard specification ASTM E1745. The vapor retarder must be placed directly underneath the concrete slab, above the granular fill, as per Manufacturer's instructions. The vapor retarder must have a perm rating of 0.1 or less and must have a minimum thickness of 10 mil (0.010in).
- .3 No concrete sealers or curing compounds are applied or mixed with the subfloors.
- .4 Installation of the resilient athletic flooring to be carried out no sooner than the specified curing time of concrete subfloor (normal density concrete curing time is approximately 28 days for development of design strength). Refer to current version of ASTM F710.
- .5 The subfloor surface must be free of any paint, wax, oil, grease, sealer, curing compound, solvent or any other contaminants that may inhibit bond. All contaminants must be removed from the surface via mechanical abatement. Use of abatement chemicals is not recommended.
- .6 Concrete to have smooth, dense finish, and be highly compacted with a tolerance of 1/8" in a 10ft radius (3.2mm in 3.05m radius). Floor Flatness (FF) and Floor Levelness (FL) numbers are not recognized.
- .7 Moisture and alkalinity tests must be performed on all concrete substrates, under in-service conditions. It is recommended to turn on the HVAC unit prior to performing moisture testing, in order to ensure stable testing conditions and accurate results. The concrete's surface pH should be between 7 and 10. Relative humidity of the

concrete slab must not exceed 85%, in accordance with ASTM F2170 (in situ probes). Moisture vapor emissions from the concrete slab must not exceed the tolerance of the adhesive specified, in accordance with ASTM F1869 (anhydrous calcium chloride).

- .8 If installing over wood subfloors, ensure exterior grade plywood with at least one good side, such as: APA (Engineered Wood Association) Exterior grade plywood (A-A Exterior, A-B Exterior or AC Exterior) and CANPLY (Canadian Plywood Association) Exterior certified plywood (Canada: Grade G2S A-A or G1S A-C. USA: G2S A-A, A-B, B-B, or G1S A-C, B-C). There must be proper underfloor ventilation, plywood must be dry and should have a moisture content ranging between 6 and 12%, when measured with a quality wood moisture meter (electronic hygrometer).
- .9 Maintain a stable room and subfloor temperature within the recommended range of 65°F to 86°F (18°C to 30°C), 48 hours prior to installation, during the installation, and 48 hours after the installation. Recommended ambient humidity control level is between 35 to 55%.
- .10 Installation of resilient athletic flooring will not commence until the building is enclosed and all other trades have completed their work. It is the General Contractor or Construction Manager's responsibility to maintain a secure

1.7 **EXTENDED WARRANTY**

- .1 The resilient athletic flooring is warranted to be free from manufacturing defects for a period of one (1) year from the date of shipment from the Manufacturer.
- .2 For applications in ice arenas, the resilient athletic flooring is warranted against excessive wear under normal usage for a period of five (5) years from the date of shipment from the Manufacturer; all other applications under normal usage will be warranted against excessive wear for a period of ten (10) years from the date of shipment from the Manufacturer.
- .3 Refer to current copy of Manufactured Product's Limited Warranty for all terms and conditions

2 Products

2.1 **ACCEPTABLE PRODUCTS (RUFL):**

- .1 Ramflex (10mm) by Mondo, Colour: Consultant to select from a standard full range of colours.
- .2 Triumph Rubber Sport Flooring (9.5mm) by Tarklett North America, Colour: Consultant to select from a standard full range of colours.

2.2 **MATERIALS**

- .1 Prefabricated resilient rubber athletic flooring, calendered and vulcanized with a base of natural and synthetic rubbers, stabilizing agents and pigmentation, as manufactured by Mondo Luxembourg S.A. or approved equal.

- .2 Phthalate-free, halogen-free, heavy metal-free, formaldehyde-free, isocyanate-free and BPA-free.
- .3 Thickness: 0.394" (10mm).
- .4 Colors: Provided in standard, solid background colors with random marbleization throughout wear layer.
- .5 Surface Texture: Hammered.
- .6 Manufactured in two layers which are vulcanized together. The shore hardness of the top layer will be greater than that of the bottom layer; shore hardness of layers to be recommended by the Manufacturer and the limits specified.
- .7 Formats: Available in sheets that are 6'1" (1.86m) wide and 29'6" (9m) long [min. 19'8" (6m)/max. 36'1" (11m)]; available in tiles that are 36" x 36" (91.35cm x 91.35cm).

2.3 **ACCESSORIES**

- .1 Provide adhesive certified by Manufacturer: Mondo PU 105 (polyurethane). For suitability, recommendations and use please refer to Manufacturer's current printed adhesive guidelines. In some cases, Mondo EP 55 (epoxy) may be used in areas that have not been specified to receive Everlay, and that will not be subject to surface impacts (such as falling free weights) or heavier dynamic loads (such as bleachers).
- .2 Patching or leveling compound to be supplied or recommended/approved by Manufacturer.

2.4 **FLOOR BASE AT RESILIENT ATHLETIC FLOORING**

- .1 Resilient base type (B-1):
 - .1 Acceptable Products/manufacturers:
 - .1 Forbo
 - .2 Johnsonite
 - .3 Roppe 'Pinnacle Rubber Base'.
 - .2 Rubber wall base, 3.2 mm (1/8") thick, 101.6 mm (4") high, with cove profile. Colour: to later selection by Consultant from manufacturer's full range. coved profile, in lengths as long as possible including premoulded end stops and inner and outer corners.

3 **Execution**

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

- .2 Ensure that concrete subfloors, on or below grade, are installed over a permanent effective vapor retarder, respecting current versions of the standard practice ASTM E1643 and the standard specification ASTM E1745. The vapor retarder must be placed directly underneath the concrete slab, above the granular fill, as per Manufacturer's instructions. The vapor retarder must have a perm rating of 0.1 or less and must have a minimum thickness of 10 mil (0.010in).
- .3 Installation of the resilient athletic flooring to be carried out no sooner than the specified curing time of concrete subfloor (normal density concrete curing time is approximately 28 days for development of design strength). Refer to current version of ASTM F710.
- .4 Ensure that no concrete sealers or curing compounds have been applied to or mixed into the concrete.
- .5 Subfloor surface must be free of any paint, wax, oil, grease, sealer, curing compound, solvent or any other contaminants that may inhibit bond. All contaminants must be removed from the surface via mechanical abatement. Use of abatement chemicals is not recommended.
- .6 Confirm concrete has smooth, dense finish, and is highly compacted with a tolerance of 1/8" in a 10ft radius (3.2mm in 3.05m radius). Floor Flatness (FF) and Floor Levelness (FL) numbers are not recognized.
- .7 Moisture and alkalinity tests must be performed on all concrete substrates, under in-service conditions. It is recommended to turn on the HVAC unit prior to performing moisture testing, in order to ensure stable testing conditions and accurate results. The concrete's surface pH should be between 7 and 10. Relative humidity of the concrete slab must not exceed 85%, in accordance with ASTM F2170 (in situ probes). Moisture vapor emissions from the concrete slab must not exceed the tolerance of the adhesive specified, in accordance with ASTM F1869 (anhydrous calcium chloride).
- .8 If installing over wood subfloors, ensure exterior grade plywood with at least one good side, such as: APA (Engineered Wood Association) Exterior grade plywood (A-A Exterior, A-B Exterior or A-C Exterior) and CANPLY (Canadian Plywood Association) Exterior certified plywood (Canada: Grade G2S A-A or G1S A-C. USA: G2S A-A, A-B, B-B, or G1S A-C, B-C). There must be proper underfloor ventilation, plywood must be dry and should have a moisture content ranging between 6 and 12%, when measured with a quality wood moisture meter (electronic hygrometer).
- .9 Maintain a stable room and subfloor temperature within the recommended range of 65°F to 86°F (18°C to 30°C), 48 hours prior to installation, during the installation, and 48 hours after the installation. Recommended ambient humidity control level is between 35 to 55%.

- .10 Installation of resilient athletic flooring will not commence until the building is enclosed and all other trades have completed their work. Ensure a secure and clean working area before, during and after the installation of the resilient athletic flooring.

3.2 **SUBFLOOR TREATMENT**

- .1 Prepare subfloor in accordance with Manufacturer's current printed guidelines.
- .2 Ensure floor surfaces are smooth, clean and cured, with trowel finish, free from curing compounds or surface coatings, in accordance with flooring manufacturer's printed installation instructions.
- .3 Remove adhesives, coatings, dirt and foreign matter, excessive dusting, broken or loose concrete, and moisture which would impair bond.
- .4 Substrate to be prepared in accordance with ASTM F710-11 "Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring".
- .5 All concrete subfloors must be tested for moisture, pH (alkalinity), and proper adhesive bond:
- .6 Moisture tests shall be conducted in accordance with ASTM F 1869 "Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride" or ASTM F 2170 "Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs using in situ Probes". Three tests should be conducted for areas up to 1,000 sq. ft. and one additional test should be conducted for each additional 1,000 sq. ft. of flooring.
- .7 Results must not exceed 5 lbs. per 1,000 sq. ft. in 24 hours when tested to ASTM F 1869, or exceed 80% when tested to ASTM F 2170.
- .8 If the tests results exceed the limitations, the installation must not proceed until the problem has been corrected.
- .9 A pH test for alkalinity must be conducted. Results should range between 7 and 9. If the test results are not within the acceptable range of 7 to 9, the installation must not proceed until the problem has been corrected.
- .10 An adhesive bond test should be performed using the actual flooring materials and adhesive to be installed. The test areas should be a minimum of 36" x 36" and remain in place for at least 72 hours and then evaluated for bond strength to the concrete.
- .11 Fill cracks, grooves, voids and /or construction joints with levelling compound as approved by manufacturer. High spots on the floor shall be removed by grinding them down.
- .12 Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.
- .13 Apply sub-floor filler to low spots and cracks to achieve floor level to a tolerance of 1:1000, allow to cure.

- .14 Clean and remove all deleterious materials from surfaces to receive this Work in accordance with the adhesive manufacturer's recommendations.
- .15 Prime concrete to flooring manufacturer's printed instructions.

3.3 RESILIENT ATHLETIC FLOORING APPLICATION

- .1 Install tiles of resilient athletic flooring following Manufacturer's current printed guidelines.
- .2 Install all accessories following Manufacturer's current printed guidelines.
- .3 Dry-lay entire floor tile area. Check tiles for possible imperfections or defects including trim, thickness and colour. Replace any defective material prior to adhesion.
- .4 Install flooring to entire area indicated or scheduled, including coverplates occurring within finished floor areas. Maintain overall continuity of colour and pattern with pieces of flooring installed on cover plates. Tightly butt edges to perimeter of floor around cover plates and to cover plates. Do not install flooring to floor drains occurring within finished floor areas.
- .5 Apply adhesive uniformly using recommended trowel in accordance with flooring manufacturer's written instructions. Do not spread more adhesive than can be covered by flooring before initial set takes place.
- .6 Remove any excessive adhesive from surfaces of the floor and base as work progresses.
- .7 Lay tiles in pattern as selected by Consultant. Do not pressure fit tile joints.
- .8 Trim and fit neatly around fixed objects.
- .9 Terminate flooring at centerline of door in openings where adjacent floor finish or colour is dissimilar, unless otherwise indicated.
- .10 Protect laid flooring from construction traffic for a period as recommended by manufacturer. At the end of this time, thoroughly clean all surfaces with a neutral cleaner as approved by manufacturer of flooring materials.
- .11 Protect floors from time of final set of adhesive until final inspection. Install suitable protection sheeting, lap joints of material by 150 mm (6") and seal with non-asphaltic tape.
- .12 Install floor protection in areas where work of other sections, repairs and installation of equipment, and foot traffic will occur.
- .13 Terminate flooring at centreline of door in openings where adjacent floor finish or colour is dissimilar.
- .14 Install reducing edge strips at unprotected or exposed edges where flooring terminates or where there are two finishes of different thicknesses.

- .15 Trowel: porous and non-porous substrate: 1/8" x 1/8" x 1/16" "V" notch Determine subfloor porosity and follow the adhesive label instructions regarding porous and non-porous substrate drying times prior to the installation of the rubber floor tiles.
- .16 Square the area and establish reference points on substrate.
- .17 Lay out the tile so that a minimum of one-half of a tile forms the border along the perimeter.
- .18 Apply the adhesive to the substrate. Follow directions on adhesive label for proper adhesive use.
- .19 Use established reference points and install the flooring.
- .20 Lay tiles with the directional arrow (found on back of each tile) pointing in the same direction.
- .21 Pattern tiles may be 'quarter turned' to create a checkerboard pattern.
- .22 Tiles should be lightly butted together when placing the flooring into the adhesive.
- .23 Do not force tiles together creating a ledge condition at the seams and corners. Sliding tiles will result in forcing the adhesive out between the seams.
- .24 Work off the flooring when using adhesive or use kneeling boards.
- .25 Periodically, lift the corner of an installed tile to ensure proper transfer of adhesive.
- .26 Roll floor in both directions with a 100 pound three-section roller. Use a hand roller in areas that cannot be reached with a large roller.
- .27 Inspect the floor surface, especially seams, and remove any adhesive on the surface.

3.4 TRAFFIC

- .1 No traffic for 24 hours after installation.
- .2 No heavy traffic, rolling loads, or furniture placement for 72 hours after installation.

3.5 REPAIR

- .1 Repair material must come from the same original dye lot as original the Manufactured Product initially installed.
- .2 Repairs are to be performed by qualified installers/technicians only.

3.6 CLEANING AND SEALING

- .1 Always wait at least a minimum of 72 hours after the resilient athletic flooring has been completely installed before performing initial maintenance.
- .2 Always maintain the resilient athletic flooring following Manufacturer's current printed guidelines.

3.7 PROTECTION OF FINISHED WORK

- .1 As needed, protect resilient athletic flooring with 1/8" Masonite during and after the installation, prior to acceptance by the Owner.
- .2 Protect exposed edges of resilient flooring, where finished and unfinished areas adjoin, by means of a reducing strip butting to and flush with the finished surface of the flooring covering material and securely adhered to the substrate material.
- .3 Install reducing strips where flooring terminates. Set flush with adjacent floor finishes.

END OF SECTION

- 1** General
- 1.1** **SECTION INCLUDES**
 - .1 Labour, Products, equipment and services for washroom accessories work in accordance with the Contract Documents.
- 1.2** **REFERENCES**
 - .1 CAN/CSA B651-M, Barrier Free Design.
 - .2 ASTM A167, Specification for Stainless Steel and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- 1.3** **SUBMITTALS**
 - .1 Shop drawings: Submit shop drawings in accordance with Section 01 33 00 indicating fabrication and erection details, plans, elevations, hardware, and installation details.
 - .2 Samples:
 - .1 Submit samples in accordance with Section 01 33 00.
 - .2 Submit 300 x 300 mm samples for each colour.
 - .3 Submit samples of each hardware item, including brackets, fastenings, and trim.
- 1.4** **MAINTENANCE DATA**
 - .1 Provide maintenance data for maintenance of finished work for incorporation into General Requirements specified in Section 01 33 00.
- 1.5** **PROTECTION**
 - .1 Cover finished surfaces with heavy Kraft paper or put in cartons during shipment. Protect installed surfaces by approved means. Do not remove until immediately prior to final inspection.
- 2** Products
- 2.1** **ACCEPTABLE MANUFACTURERS**
 - .1 Floor Mounted Overhead Braced Extended Privacy;
 - .1 Compact Grade Laminate (CGL) Extended Privacy Partitions by Bobrick
 - .2 Euro Style Partitions – Highrise Series by Bradley Corporation.
- 2.2** **MATERIALS**
 - .1 All materials under Work of this Section, including but not limited to, adhesives are to have low VOC content limits.
 - .2 Phenolic partitions: Stiles and doors are 3/4" (19mm) thick, panels are 1/2" (13mm) thick solidly fused plastic laminate with matte-finish melamine surfaces, colored face sheets, and black phenolic-resin core that are integrally bonded. Colour: to be selected from full range of standard colours by the Consultant.
 - .3 Hardware:

- .1 Hinges: concealed, heavy duty stainless steel casting, self-lubricating inward swing, gapless privacy interlocking edges.
- .2 Slide bolt and keeper: Stainless steel casting or extrusion, equipped for emergency access.
- .3 Door stop: Stainless steel casting or extrusion with rubber insert.
- .4 Connecting brackets: channel shaped, stainless steel extrusion or casting, continuous.
- .5 Coat hook: combination hook and door bumper, stainless steel casting.
- .4 Stainless steel sheet metal: ASTM A167, Type 304 with No. 4 satin finish.
- .5 Fasteners: Stainless steel tamperproof type screws and bolts.

2.3 FABRICATION

- .1 Toilet partitions shall be floor mounted, overhead braced with aluminum headrail.
- .2 Fabricate stiles and doors of 19 mm thick solid plastic and feature Gapless Privacy interlocking edges.
- .3 Fabricate and provide non-see-through style doors and pilasters by fabricating doors and pilasters with 45 deg. bevelled edges, with 6 mm gap between door and pilaster.
- .4 Unless otherwise indicated or required, doors shall be nominal 610 mm wide, except doors to compartments for the handicapped shall be 810 mm wide.
- .5 Fabricate headrail of brake formed anti-grip 1.5 mm thick clear anodized aluminum with satin finish.
- .6 Fabricate pilaster boot assembly for bottom, of 1.5 mm thick die formed stainless steel. Fabricate assembly in size to suit pilaster.

3 Execution

3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

3.2 INSTALLATION

- .1 Install compartments and cubicles in accordance with manufacturer's details and reviewed shop drawings, for a secure, plumb, square, and rigid installation.
- .2 Provide connecting brackets and secure to building structure and to pilasters. Insert edge of panels and closure pilasters into brackets and secure with through type sleeve bolt and nut.
- .3 Install doors with 6 mm to 10 mm maximum space between door panel and pilasters.
- .4 Install panels with 6 mm maximum space between panels and walls.
- .5 Install hardware in accordance with manufacturers' instructions and CAN/CSA B651-M.

- .6 Make compartments adjustable with screw jack through steel saddles made integral with pilaster. Conceal fixings with stainless steel shoes.
 - .7 Provide for adjustment of floor variations with screw jack through steel saddles made integral with pilaster. Conceal floor fixings with stainless steel boot assemblies.
 - .8 Install door tops edges aligned parallel with top edges of side partitions; determine alignment when doors are in closed position.
 - .9 Brace through top of pilasters with rectangular shaped anti-grip headrail and fasten with stainless steel sheet metal screws.
 - .10 Set panels, and doors level and in line, raised approximately 300 mm above finished floor.
 - .11 Hang doors to remain stationary at open position.
 - .12 Equip each door with hardware. Adjust and align hardware for easy, proper function.
 - .13 Provide closure pilasters, as required, at end units of compartment bank.
 - .14 Remove and replace damaged components not acceptable to Consultant.
- 3.3 **SCREEN ERECTION**
- .1 Provide urinal stall screens consisting of panel and framing/supports as specified for toilet compartments.
 - .2 Anchor screen panels to walls with wall hung urinal screen brackets and vertical upright post complete with floor and ceiling boot assembly.
- 3.4 **ADJUSTING**
- .1 Adjust operating hardware to work smoothly and without force. Adjust hinges of compartment doors so that all doors remain open to the same degree when unlatched, except doors at handicapped cubicles shall close automatically.

END OF SECTION

- 1 General**
- 1.1 SECTION INCLUDES**
 - .1 Labour, Products, equipment and services for washroom accessories work in accordance with the Contract Documents.
- 1.2 REFERENCES**
 - .1 ASTM A167, Specification for Stainless Steel and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - .2 ASTM A312, Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
 - .3 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .4 CAN/CSA B651-M, Barrier Free Design.
- 1.3 SUBMITTALS**
 - .1 Product data: Submit Product data to requirements of Section 01 33 00 indicating each washroom accessory describing size, finish, details of function, attachment methods, hardware and locks, description of rough-in frame, and building-in details of anchors for grab bars.
 - .2 Closeout submittals:
 - .1 Submit for each Product operation and maintenance instructions for incorporating into the Operations and Maintenance Manuals in accordance with Section 01 33 00.
 - .1 Supply 2 keys for each lockable washroom accessory to Consultant.
 - .2 Master key washroom accessories which are keyed.
- 1.4 DELIVERY, STORAGE AND HANDLING**
 - .1 Deliver materials in sealed cartons and containers with manufacturer's name and product description clearly marked.
- 1.5 EXTENDED WARRANTY**
 - .1 Submit an extended warranty for washroom accessories work in accordance with the General Conditions, except that the warranty period is extended to 10 years.
 - .1 Against cracked or scratched mirrors, spoiling or deterioration of silvering or backing, loosening of fastenings or adhesive
 - .2 Coverage: complete replacement including effected adjacent work.
- 1.6 MAINTENANCE**
 - .1 Maintenance Tools: Provide special tools necessary for accessing, assembly/disassembly or removal of toilet, bath and cleaning accessories in accordance with Section 01 33 00.

2 Products

2.1 MATERIALS

- .1 Stainless steel:
 - .1 Sheet metal: ASTM A167, Type 304.
 - .2 Tubing: ASTM A312, Type 304.
- .2 Sheet steel: ASTM A653M, Z275; Cold rolled, commercial quality, surface preparation and pre-treatment as required for applied finish.
- .3 Fasteners, screws and bolts: ASTM A167, Type 304 stainless steel, tamper-proof.

2.2 ACCESSORIES

- .1 Refer to drawings for quantity and location of washroom accessories.
- .2 Toilet tissue dispenser (TTD):
 - .1 #B-2888 by Bobrick or #0030 by ASI Group Canada; Surface mounted, multi roll dispenser, with second roll enclosed in cabinet above.
 - .2 Finish: Type 304 stainless steel with satin finish.
- .3 Waste Receptacle (WR)
 - .1 #B-279 by Bobrick or approved alternative by ASI/Watrous or Bradley Corporation; Surface mounted 355 x 455 x 150mm receptacle.
 - .2 Finish: Type 304 stainless steel with satin finish.
- .4 L-Shaped Grab bar (GBR-1):
 - .1 '3200 Series' by ASI/Watrous or approved alternative by Bobrick or Bradley Corporation; 760mm length, 38 mm diameter, 1.2 mm thick, concealed mounting with flange, L-shape as indicated on drawings.
 - .2 Finish: Type 304 stainless steel with a satin finish and peened grip.
- .5 L-Shaped Grab bar (GBR-2):
 - .1 '3200 Series' by ASI/Watrous or approved alternative by Bobrick or Bradley Corporation; 1000mm length, 38 mm diameter, 1.2 mm thick, concealed mounting with flange, L-shape as indicated on drawings.
 - .2 Finish: Type 304 stainless steel with a satin finish and peened grip.
- .6 Grab bar (GBR-3):
 - .1 '3200 Series' by ASI/Watrous or approved alternative; 600 mm length, 38 mm diameter, 1.2 mm thick, concealed mounting, complete with escutcheons as indicated on drawings.
 - .2 Finish: Type 304 stainless steel with a satin finish and peened grip.
- .7 Grab bar (GBR-4):
 - .1 '3200 Series' by ASI/Watrous or approved alternative; 750 mm length, 38 mm diameter, 1.2 mm thick, concealed mounting, complete with escutcheons

- as indicated on drawings.
- .2 Finish: Type 304 stainless steel with a satin finish and peened grip.
- .8 Grab bar (GBR-5):
 - .1 '3200 Series' by ASI/Watrous or approved alternative; 1000 mm length, 38 mm diameter, 1.2 mm thick, concealed mounting, complete with escutcheons as indicated on drawings.
 - .2 Finish: Type 304 stainless steel with a satin finish and peened grip.
- .9 Soap dispenser (SD):
 - .1 6A03-11 by Bradley Corporation or approved alternative; Vertical surface wall mounted dispenser, 100 mm from wall to automatic, 1.18 -litre capacity stainless steel container with tamper resistant sight gauge.
 - .2 Finish: Type 304 stainless steel with satin finish.
- .10 Mirror:
 - .1 Mirror (MIRROR-1) 6 mm thick, mirror quality float glass
 - .2 #B-290 Series by Bobrick or #20650 series by ASI Group Canada; mitred corners welded, and polished smooth.
 - .1 Dimensions: 24"W x 36" H (61 x 91cm)
 - .2 Frame finish: Type 304 stainless steel satin finish.
- .11 Barrier-free mirror with shelf (MIRROR-2):
 - .1 #B-166 1830 by Bobrick; 6 mm thick, mirror quality float glass complete with stainless steel channel frame with galvanized steel back having integral horizontal hanging brackets, integral stainless steel shelf with return edge and galvanized steel concealed wall hanger.
 - .2 Frame finish: Type 304 stainless steel satin finish.
 - .3 Locations as indicated on the Contract Drawings.
- .12 Full Length Mirror:
 - .1 Mirror (MIRROR-3) 6 mm thick, mirror quality float glass
 - .2 #0600 series by ASI Group Canada or approved equivalent; mitred corners welded, and polished smooth.
 - .1 Dimensions: 36"W x 72" H (914mm x 1829mm)
 - .2 Frame finish: Type 304 stainless steel satin finish.
- .13 Coat hook (CH) :
 - .1 HDP005IP – Henkelhook Safety Release Coat Hook by Richelieu or approved alternative.
 - .2 Finish: Consultant to select from full arrange of standard colours.
- .14 Baby changing station (CHTB):

- .1 Horizontal baby changing station complete with liners.
- .2 Model: Sturdy Station 2 by Rubbermaid or approved alternative.
- .15 Backrest:
 - .1 Provide barrier-free backrests in all accessible washrooms where shown on Contract Drawings.
 - .2 Backrest to be fabricated from 32 mm o.d. stainless steel tubing having a satin finish, complete with concealed mounting and a 16 mm thick solid panel finished with white plastic laminate.
 - .3 Backrest, 'Model 1028' by Frost Products Ltd. or approved alternative.
- .16 Sanitary napkin disposal (ND):
 - .1 #B-270 by Bobrick or approved alternative by ASI Group Canada; Surface mounted, top hung upper door with multi-staked piano hinge, surface mounted stainless steel wall box and waste receptacle, full length stainless steel hinge. Receptacle capacity: 3.8 L.
 - .2 Finish: All exposed edges Type 304 stainless steel with satin finish.
- .17 Stainless Steel Shelf:
 - .1 #B-298 x 24 by Bobrick or approved alternative by ASI/Watrous or Bradley Corporation;; shelf fabricated from 1.2 mm thick stainless steel with 19 mm return edge and front edge hemmed for safety.
 - .2 Shelf complete with brackets fabricated from 1.6 mm thick stainless steel.
 - .3 Size: 200 mm wide x 600 mm length.
 - .4 Finish: Type 304 stainless steel, satin finish.
- .18 Shower Seat (FSS):
 - .1 'B-5191' Folding Shower Seat by Bobrick or approved alternative by ASI/Watrous or Bradley Corporation; 455 mm x 400mm seat.
 - .2 Finish: Solid Phenolic
- 3 Execution**
- 3.1 EXAMINATION**
 - .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- 3.2 INSTALLATION**
 - .1 Verify and coordinate templates, inserts, and rough-in frames and verify exact location of washroom accessories for installation.
 - .2 Verify there is adequate supports and/or blocking in gypsum wall assemblies prior to installation of washroom accessories.
 - .3 Provide fastening and mounting kits for washroom accessories.

- .4 Locate washroom accessories where indicated on Drawings and where directed by Consultant.
- .5 Install washroom accessory fixtures, accessories, and items in accordance with manufacturer's instructions and CAN/CSA B651-M. Provide exposed tamper-proof screws of stainless steel to match units.
- .6 Install washroom accessories plumb, level, and securely and rigidly anchored to substrate surfaces and framing. Adjust accessories for proper operation and verify mechanisms function smoothly.
- .7 Install grab bars to withstand minimum 408 kg downward pull. Provide necessary reinforcements as required.
- .8 Clean and polish exposed surfaces

END OF SECTION

- 1** General
- 1.1** **SECTION INCLUDES**
 - .1 Labour, Products equipment and services necessary for the miscellaneous specialties Work in accordance with the Contract Documents.
- 1.2** **SUBMITTALS**
 - .1 Product data:
 - .1 Submit manufacturer's Product data for each Product specified in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard(s),
 - .2 Product transportation, storage, handling and installation requirements.
 - .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating elevations, sections, details, dimensions, materials, gauges, and finishes.
 - .3 Closeout submittals: Submit cleaning and maintenance instructions for miscellaneous specialties for incorporation into Operations and Maintenance Manuals in accordance with Section 01 33 00.
- 1.3** **DELIVERY, STORAGE, AND HANDLING**
 - .1 Package or crate, and brace products to prevent distortion in shipment and handling. Label packages and crates, and protect finish surfaces by sturdy wrappings.
- 2** Products
- 2.1** **MATERIALS**
 - .1 Access doors (non-fire rated walls and ceilings):
 - .1 Access door, "Bauco Plus II TX" by Access Panel Solutions or approved alternative.
 - .2 Seamless access panel for gypsum board with concealed aluminum frame with continuous factory installed perimeter EPDM gasket, galvanized steel hardware, pivoting hinge and steel safety cable with clip for ceiling operation.
 - .3 Provide concealed mechanical touch-latch for ceiling access doors and tamper-resistant torx head can latch lock for wall and ceiling applications.
 - .4 Door size as approved by the Consultant for intended applications.
 - .5 Finishing: In accordance with Section 09 91 00.
 - .2 Access doors (tiled insert – walls):

- .1 Access door, "Bauco Plus II TX" by Access Panel Solutions or approved alternative.
- .2 Seamless access panel for gypsum board with concealed aluminum frame with continuous factory installed perimeter EPDM gasket, galvanized steel hardware, pivoting hinge and steel safety cable with clip for ceiling operation.
- .3 Provide concealed mechanical touch-latch for ceiling access doors and tamper-resistant torx head cam latch lock for wall and ceiling applications.
- .4 Door size as approved by the Consultant for intended applications.
- .5 Finishing: In accordance with Section 09 30 00 and 09 91 00.
- .6 Install bench brackets and supports supplied under work of Section 05 50 00.

3 Execution

3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

3.2 PREPARATION

- .1 Verify substrate surfaces are solid, free from surface water, dust, oil, grease, projections and other foreign matter detrimental to performance.
- .2 Items to be built-in: Provide information and templates required for installation of work of this Section, and assist or supervise, or both, the setting of anchorage devices, and construction of other work incorporated with products specified in this Section in order that they function as intended.
- .3 Verify there is adequate supports and / or blocking in gypsum wall assemblies prior to installation of miscellaneous speciality items as required.

3.3 INSTALLATION

- .1 Install miscellaneous specialties level and securely and rigidly anchored to substrate in accordance with authorities having jurisdiction, reviewed shop drawings, and manufacturer's written instructions.
- .2 After installation, adjust miscellaneous specialties in accordance with manufacturer's written instructions.

3.4 CLEANING

- .1 Clean and polish exposed surfaces prior to acceptance by Consultant.

END OF SECTION

- 1** General
 - 1.1 SECTION INCLUDES**
 - .1 Labour, Products equipment and services necessary for the shower curtain Work in accordance with the Contract Documents.
 - 1.2 SUBMITTALS**
 - .1 Samples: Submit samples of the following in accordance with the requirements of Section 01 33 00:
 - .1 Submit manufacturer's Product data sheets for Products proposed for use in the work of this section.
 - .2 Indicate curtain stack depth, stack size, and depth from wall obstruction.
 - .3 Submit 3 samples of each type and colour of curtain fabric specified, 300 mm x 300 mm (12" x 12"), for acceptance of colour and construction by Consultant. Obtain acceptance from Consultant prior to ordering material.
 - 1.3 QUALITY ASSURANCE**
 - .1 Installers / applicators / erectors: Provide work of this section, executed by competent installers with minimum 5 years experience in application of Products specified and with approval and training of Product manufacturer.
 - 1.4 DELIVERY, STORAGE, AND HANDLING**
 - .1 Product shall be delivered to the Place of the Work in manufacturer's original packaging.
 - .2 Product shall be handled and stored to prevent damage to materials, finishes and operating mechanisms.
- 2** Products
 - 2.1 MATERIALS**
 - .1 Track; manual/cord operated:
 - .1 Heavy duty aluminum cord operated track system with roller gliders on rim of front channel.
 - .2 Acceptable Product: Silent Gliss '6200'.
 - .3 Load: 70 kg maximum curtain weight.
 - .4 Mounting: ceiling.
 - .2 Fabric; fire retardant:
 - .1 Acceptable Product: Privacy Curtain – Flourish 2
 - .2 Width: 1680 mm (66").
 - .3 Colour: To be selected from full range of standard colours
 - .3 Fabrication:
 - .1 4 panels.

- .2 Wave, 76 mm (3") wide heading tape, plastic hooks. .3 Bottom hems: 152 mm (6") with weight
- .3 Side hems: 50 mm (2").
- .4 Fullness: 2.3.
- .5 Wand: on both sides of panels.
- .6 Length: custom, 1500 mm at finished floor.

3 Execution

3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

3.2 INSTALLATION

- .1 Install work to meet manufacturer's recommended specifications, true, tightly fitted, and level or flush to adjacent surfaces, as suitable for installation.
- .2 Include reinforcing, anchorage and mounting devices required for the installation of each product.

3.3 DRAPERY TRACK INSTALLATION

- .1 Set assemblies plumb, square, and level.
- .2 Install with securely anchored brackets at 600 mm (24") on centre.
- .3 Fit track with end stops where applicable.
- .4 Use only compatible, non-corrosive fasteners for installation, and conceal in final assembly unless otherwise specifically permitted by Consultant.

3.4 INSTALLATION TOLERANCES

- .1 Install level, tight and secured.
- .2 Comply with the following maximum tolerances:
 - .1 Level: 3 mm (1/8").
 - .2 Variation from indicated position: plus/minus 3 mm (1/8").

3.5 ADJUSTING AND CLEANING

- .1 Verify under work of this section that installed products function properly, and adjust them accordingly to ensure satisfactory operation.
- .2 Refinish damaged or defective work so that no variation in surface appearance is discernible.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Conform to the conditions stated in the Contract Form Document as per contract, Supplementary Conditions and Division 01 - General Requirements of these Specifications.

1.1.2 The General Mechanical Requirements apply to all Sections of this Division and of Divisions 21, 22, 23 and 25.

1.1.3 The Specifications are arranged generally in accordance with the MasterFormat 2004 Edition. Sections of this Division are not intended to delegate functions or to delegate work to any specific Subcontractor(s).

1.2 DEFINITIONS

1.2.1 “Provide” means to supply and install the Products and services specified in the Contract Documents.

1.2.2 “The Work” means the total construction and related services required by the Contract, and it includes all labour, products, and services.

1.2.3 “Products” means all material, machinery, equipment, and fixtures forming part of the Work but does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work which is normally referred to as construction machinery and equipment.

1.2.4 “This Division” means all Subcontractors performing work under the Mechanical Contract, including Divisions 21, 22, 23 and 25.

1.2.5 “Other Divisions” means other Subcontractors not included in this Division.

1.2.6 “Balancing Subcontractor” means the Subcontractor responsible for the balancing work.

1.3 INTENT

1.3.1 Provide all work, including items, articles, materials, operations, and methods listed, mentioned, and scheduled in the Contract Documents. Include all labour, equipment, tools, scaffolds, and other incidentals necessary and required for the complete installation.

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- 1.3.2 Consider the Specifications as an integral part of the Drawings, which accompany them. Do not use the Drawings or the Specifications alone. Consider any item or subject omitted from one, but mentioned or reasonably implied in the other, as properly and sufficiently specified and provided under the work of this Division.
- 1.3.3 This installation shall be made in strict accordance with the Drawings, Specifications, and all applicable codes, regulations, standards, bylaws, including the Ontario Building Code, requirements of local authorities having jurisdiction, Owner's Insurers', and NFPA regulations. Codes, standards, and regulations referenced by these Specifications shall be the latest edition as applicable at the time of building permit application unless noted otherwise or specifically defined under the OBC.
- 1.3.4 All equipment and devices used shall be UL/cUL listed and/or CSA certified where applicable.
- 1.3.5 Each Subcontractor is considered an expert in their field.
- 1.4 **EXAMINATION OF SITE AND CONTRACT DOCUMENTS**
- 1.4.1 Before tendering, visit the Site of the proposed Work and obtain all information as to existing conditions and limitations.
- 1.4.2 Examine the Specifications and all Drawings including the Specifications and Drawings of all other Divisions before commencing any portion of the work to this Division.
- 1.4.3 No allowance will be made for any consideration that may have been overlooked.
- 1.4.4 Unless exceptions are specifically noted in the Contract Documents at the time of Tender, the submission of a bid confirms that the Contract Documents and the Site conditions are accepted without qualification.
- 1.5 **SCOPE**
- 1.5.1 Major aspects of the work of this Division shall include, but not necessarily be limited to, the following items. Refer to Contract Drawings for the full scope of the Work included in the Contract.
- 1.5.1.1 Heating, Ventilation, and Air Conditioning (HVAC) systems, consisting of heat recovery air handling units supplemented by

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- heat pumps, general exhaust and sanitary exhaust systems, associated ductwork, grilles, diffusers, humidifiers and controls.
- 1.5.1.2 Service areas (electrical rooms, IT rooms, etc.) cooling systems, consisting of 2-pipe, cooling only heat pump units, associated ductwork, grilles, diffusers and controls.
- 1.5.1.3 Supplementary heating systems, consisting of hydronic fan-forced heaters, cabinet heaters, unit heaters, wallfin radiation, radiant panels, associated controls, as required.
- 1.5.1.4 Central condenser water plant consisting of water-source heat pumps, hydronic separator, condenser water pumps, piping, valving, water treatment and controls.
- 1.5.1.5 Plumbing systems, including incoming water services with water meters and inline filters, domestic cold water, sanitary drain and vent risers.
- 1.5.1.6 Central domestic hot water plant consisting of 90 kW (307 MBH) electric boiler, 303 L hot water storage tank, distribution piping and recirculation system. Plumbing distribution piping to plumbing fixtures, public washrooms, kitchenette and laundry equipment.
- 1.5.1.7 Plumbing fixtures for public washrooms, kitchenette, housekeeping rooms, etc.
- 1.5.1.8 Storm water drainage system, including drain piping and roof drains.
- 1.5.1.9 Noise control and vibration isolation systems.
- 1.5.1.10 DDC building automation system.
- 1.5.1.11 Testing, adjusting and balancing.
- 1.5.1.12 Commissioning of mechanical systems and equipment.
- 1.6 **CONTRACT DRAWINGS**
- 1.6.1 The Drawings for the mechanical work are diagrammatic performance drawings, intended to convey the scope of the Work, and indicate general arrangement and approximate location of apparatus, fixtures, and pipe runs. The Drawings do not intend to show architectural and structural details.
- 1.6.2 Do not scale drawings, but obtain information involving accurate

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dimensions to structure from dimensions shown on architectural and structural drawings, or by site measurements. Consult general construction Drawings as well as detail Drawings to become familiar with all conditions affecting the Work and verify spaces in which the Work will be installed.

- 1.6.3 Make, at no additional cost to the Owner, any changes or additions to materials and/or equipment necessary to accommodate structural conditions (runs around beams, columns, etc.).
- 1.6.4 Alter at no additional cost to the Owner, the location of materials and/or equipment as directed, provided that the changes are made before installation and do not necessitate additional material.
- 1.6.5 Install all ceiling mounted components (diffusers, grilles, sprinklers) in accordance with reflected ceiling drawings reviewed by the Consultant.
- 1.6.6 Leave space clear and install all work to accommodate future materials and/or equipment as indicated and to accommodate equipment and/or material supplied by another Division of Work or Contract. Verify spaces in which Work is to be installed. Install all pipe runs, etc., to maintain headroom and clearances and to conserve space in shafts and ceiling spaces.
- 1.6.7 Confirm on the Site the exact location of outlets and fixtures. Confirm location of outlets for equipment supplied under other Divisions of Work or Contracts.

1.7 CONSTRUCTION DRAWINGS

- 1.7.1 Prepare dimensioned co-ordination drawings in conjunction with all Subcontractors concerned, showing sleeves, access door locations, and openings through structure and all insert sizes and locations. Show all weights on load points. Show all electrical systems, mechanical systems, conduit, and ductwork.
- 1.7.2 Prepare drawings of pump pits, equipment bases, anchors, inertia slabs, floor and roof curbs pertaining to the Mechanical Work. Base drawings upon reviewed Shop Drawings. Indicate all loads transferred to the structure.
- 1.7.3 Submit drawings approved by all trades, to the Consultant and include one complete set in each operating and maintenance instruction manual.

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1.8 SHOP DRAWINGS

- 1.8.1 Submit Shop Drawings and samples for material and equipment as listed in the Specifications. Provide one (1) electronic pdf file. Each Shop Drawing shall have a clear margin equal to half of a 216 mm x 280 mm (8-1/2" x 11") size sheet for the application of all necessary approval stamps.
- 1.8.2 Contractor shall provide a shop drawing submission schedule at the start of the project. Schedule shall indicate the description of each shop drawing and the date of submission to the Consultant.
- 1.8.3 The Consultant will only consider Shop Drawings bearing the stamp of approval of the Contractor and all Sub-Contractors involved when applicable. Check for all pertinent information such as physical dimensions, make, performance, electrical characteristics, and indicate the intended use and location before stamping these drawings approved.
- 1.8.4 Assume responsibility for accuracy of equipment dimensions related to available space and accessibility for maintenance and service, and compliance with Codes and Inspection Authorities.
- 1.8.5 Submit Shop Drawings showing the following:
- 1.8.5.1 Project name.
- 1.8.5.2 Project tag number.
- 1.8.5.3 Manufacturer's name and model number.
- 1.8.5.4 Supplier's name.
- 1.8.5.5 Approval agencies.
- 1.8.5.6 Shipping and working weight.
- 1.8.5.7 Performance characteristics.
- 1.8.5.8 Dimensions including required clearances.
- 1.8.5.9 Electrical characteristics.
- 1.8.5.10 Materials used in manufacture and type of finish.
- 1.8.5.11 Time required to fabricate and to deliver.

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- 1.8.5.12 All variations from Tender Documents.
- 1.8.5.13 Construction and field connection details.
- 1.8.5.14 Motor locations.
- 1.8.6 Shop Drawings for packaged equipment shall be submitted as complete packages, including all equipment components and details (wiring diagrams, control diagrams, etc.).
- 1.8.7 The Consultant's review shall not relieve the Contractor from responsibility for deviations from the Consultant's Drawings and Specifications, unless they have in writing, called the Consultant's attention to such deviations at the time of submission of drawings. The Consultant's review shall be construed to apply to and only to general arrangement and shall not relieve the Contractor from the entire responsibility for correctness of details and dimensions. Any fabrication, erection, setting out or other work done in advance of the receipt of stamped drawings shall be done entirely at the Contractor's risk.
- 1.8.8 Shop Drawings will be marked by the Consultant for action by the Contractor as follows:
- | Consultant's
<u>Markings</u> | Action by
<u>Contractor</u> |
|---------------------------------|--|
| Not reviewed | Product does not fall under this Division's scope and it does not affect this Division's Work in any way |
| Reviewed | Proceed with work |
| Reviewed as Noted | Proceed in accordance with mark-up. Resubmit revised drawings for record |
| Revise and Resubmit | Submit revised drawings for review before proceeding |
- 1.9 SCHEDULING

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- 1.9.1 Comply with the Contractor's construction schedule.
- 1.9.2 Provide in the tender price any costs for premium time outside of normal working hours to complete the work on schedule.
- 1.10 **RECORD DRAWINGS**
 - 1.10.1 Obtain electronic copy of the Drawings, Specifications & Contract Documents in PDF format and AutoCAD/Revit drawing files from a central project management website. If such a website is not set-up for the project, obtain electronic copy of the Drawings, Specifications & Contract Documents in PDF format and AutoCAD/Revit drawing files from the Consultant via email or other electronic file transfer tool used by the Consultant, after returning Consultant's waiver signed. As the job progresses, produce white prints of the relevant drawings and mark the prints to accurately indicate installed work. Have the white prints available for inspection at the site at all times, and present for scrutiny at job meeting. Transfer all information onto the AutoCAD drawing files/Revit model. Drawing files shall retain all original layering standards. Submit one (1) set of AutoCAD drawing files/Revit model files and one (1) set of pdf files, via email or other mutually agreed electronic file transfer tool, of final "Record" documents (drawings and specifications) to the Consultant for review. Note that the consultant's AutoCAD drawing files/Revit model files are copyrighted and may not be used for any other purpose other than that described above.
 - 1.10.2 The drawing files shall be provided solely to assist the Subcontractor in the preparation of "Record" drawings. The Consultant assumes no liability for any errors, omissions, incomplete information, incorporation of latest changes, or other instructions.
 - 1.10.3 While the Consultant takes precautions to ensure that no computer virus is transmitted, scanning for viruses upon receipt is recommended.
 - 1.10.4 Prepare Record Drawings showing the following:
 - 1.10.4.1 Inverts of all services entering and leaving the building and at property lines.
 - 1.10.4.2 Dimensions of underground services in relation to building lines at key points of every run.

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- 1.10.4.3 Elevations of underground services in relation to Ground floor level of the building.
- 1.10.4.4 Dimensioned location of all services embedded in the structure.
- 1.10.4.5 Dimensioned location of all services left for future Work.
- 1.10.4.6 All Addendum changes.
- 1.10.4.7 All changes to the work due to Change Orders.
- 1.10.4.8 All changes to the Work during construction.
- 1.10.4.9 Location and designation of all electrically supervised valves and smoke dampers.
- 1.10.4.10 Location and designation of all items requiring access or service in a hidden location.
- 1.10.4.11 All changes to Specifications, details and equipment schedules.
- 1.10.4.12 All duct traverse points and associated airflow rates as reported in final Air Balancing reports.
- 1.10.5 Identify each "Record" drawing as follows, "Record Drawing: This drawing has been revised to show all systems as installed. Remove references to the Consultant.
- 1.10.6 Prior to Testing, Adjusting and Balancing, provide print copies of all current record drawings to the Balancing Subcontractor and the Commissioning Agent.
- 1.11 **PRODUCTS**
 - 1.11.1 Provide only new Products. Where manufacturer is not specified provide Products of high commercial standard and quality consistent with the standards of these Specifications.
 - 1.11.2 All Products must bear the approval of the CSA or have special approval of the inspection authority having jurisdiction for their respective functions and environments.
 - 1.11.3 Provide products of same manufacture for similar applications unless noted otherwise in the Contract Documents.
 - 1.11.4 Refer to equipment performance schedules in the respective Specification Section and on the Drawings.

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1.12 ALTERNATES AND SUBSTITUTIONS DURING PROGRESS OF WORK

1.12.1 Substitute Products will only be considered when Products specified in the Contract Documents become unobtainable.

1.12.2 Provide detailed Specifications and Shop Drawings with complete performance characteristics of the proposed alternate with the submission to the Consultant.

1.12.3 Assume responsibility and pay for any additional installation costs incurred by the work of all Divisions resulting from the substitution.

1.13 VALUATION OF CHANGES

1.13.1 For each change submit a complete itemized breakdown of labour and material.

1.13.2 Only the net difference between an extra and a credit will be subject to overhead and profit mark-up. Overhead and profit shall be as shown on the Tender Form.

1.14 APPLICATION FOR PAYMENT

1.14.1 Conform to the Consultant's method of submission of application for payment, which will be issued after the award of Contract.

1.15 SUPERINTENDENCE

1.15.1 The supervisory staff assigned to the project shall be fully competent to implement efficiently all requirements for scheduling, coordination, field engineering reviews, inspections and submittals defined in the Specifications.

1.16 INSTALLATION REQUIREMENTS

1.16.1 The Consultant's Drawings and instructions govern the general location of all items.

1.16.2 Install all equipment and apparatus to allow free access for maintenance, adjustment and replacement.

1.16.3 Install all Products and services in accordance with the manufacturer's requirements and/or recommendations.

1.16.4 Do not use explosive activated tools.

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- 1.16.5 Install all services capped for future to allow easy access for future tie-in.
- 1.16.6 All equipment installed in parking structure floor slabs, ramps and driving areas shall meet all requirements of CAN/CSA-S413-07 with regard to corrosion protection:
 - 1.16.6.1 The use of dissimilar materials shall be avoided, or if unavoidable, electric contact shall be prevented.
 - 1.16.6.2 Embedded materials used for floor drains, pipes and other hardware shall be:
 - 1.16.6.2.1 Non metallic, or;
 - 1.16.6.2.2 A low copper aluminum alloy or an equally corrosion resistant metal, coated on surfaces in contact with concrete to prevent galvanic corrosion with steel reinforcing, or;
 - 1.16.6.2.3 Protected against the corrosive effects of de-icing chemicals by an effective and durable coating.
- 1.16.7 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise in the Contract Documents, install all Products and services to follow building planes. Installation shall permit free use of space and maximum headroom.
- 1.16.8 Cap off and seal all open ends of installed ductwork, piping and conduits to prevent entrance of foreign matter.
- 1.16.9 Do not install piping in a location or manner, which might result in freezing.
- 1.17 **TEMPORARY SERVICE**
 - 1.17.1 Refer to Section 01 50 00 regarding temporary services, Contractor's shop, storage and other facilities.
 - 1.17.2 Do not use any of the permanent mechanical systems during construction, unless specific written permission is obtained from the Consultant or unless allowed elsewhere in the Contract Documents.
 - 1.17.3 The use of permanent facilities for temporary construction service shall not affect in any way the commencement of the warranty period. The warranty period shall commence as specified in the Contract Documents.

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1.18 COOPERATION

- 1.18.1 Confer with all Subcontractors installing equipment that may affect the work of this Division, and arrange equipment in proper relation with equipment installed under other Divisions of the Contract.
- 1.18.2 Furnish all items to be built in, in time, complete with all pertinent information, commensurate with the progress of the work.
- 1.18.3 Store materials neatly and out of the way and clean up daily all refuse caused by the work.
- 1.18.4 Coordinate work with the work of all other Divisions. Relocate equipment and/or material installed, but not coordinated with the work of other Divisions, as directed by the Consultant, at no extra cost. Inform other Divisions of the locations of openings, chases, sleeves, supports, services, connections, etc. to be incorporated into the work.

1.19 PROTECTION

- 1.19.1 Protect building and structure from damage due to carrying out this work.
- 1.19.2 Protect all mechanical work from damage. Keep all equipment dry and clean at all times.
- 1.19.3 Cover all openings in equipment and materials.
- 1.19.4 Be responsible for and make good any damage caused directly or indirectly to any walls, floors, ceilings, woodwork, brickwork, finishes, etc.

1.20 FIELD REVIEW

- 1.20.1 The Consultants will make periodic visits to the Site during construction to ascertain reasonable conformity to plans and specifications. The Consultant is not responsible for quality control. Contractor shall maintain their own quality control and will be responsible for the execution of their work in conformity with the Contract Documents and with the requirements of authorities.
- 1.20.2 The Owner and Consultant shall have access to the Site at all times for periodic inspections. Maintain a complete set of contract documents on Site for field reference by the Consultant.
- 1.20.3 Provide all gauges, instruments, and other equipment necessary

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for field review by the Consultant.

1.20.4 Application for final review will be considered when the Work has been completed and written declarations submitted that all commissioning, adjustment, set up and documentation is complete. Final review shall be done when:

1.20.4.1 All reported deficiencies have been corrected.

1.20.4.2 All systems have been balanced, tested, commissioned and are operational.

1.20.4.3 The Owner has been instructed in the operation and maintenance of all equipment.

1.20.4.4 All reports have been submitted and reviewed.

1.20.4.5 All instruction manuals have been submitted and reviewed.

1.20.4.6 All tags and nameplates are in place and all data submitted and reviewed.

1.20.4.7 Cleaning up is finished in all respects.

1.20.4.8 All spare parts and replacement parts specified have been provided.

1.20.4.9 All record drawings have been submitted and reviewed.

1.21 SERVICES TO EQUIPMENT SUPPLIED BY OTHERS

1.21.1 Provide all necessary connections required for equipment supplied by the Owner and the work of other Divisions. Examine all the Drawings and Specifications and identify all requirements.

1.21.2 Provide valves, unions, caps, and vibration isolation for all services.

1.21.3 The Contractor shall be responsible to verify, adjust and coordinate the type, size and location of mechanical services required for all equipment supplied by the Owner and the work of other Divisions.

1.22 PROVISION FOR FUTURE EQUIPMENT AND CONSTRUCTION

1.22.1 Spaces designated for future equipment or building expansion shall be left clear.

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1.22.2 Provide services for future extensions complete with Products necessary for present termination and to permit future extension.

1.22.3 Identify each service by a permanent marker at its termination point.

1.23 CUTTING AND PATCHING

1.23.1 Inform all other Divisions in time, concerning required openings. Where this requirement is not met, bear the cost of all cutting and patching, including layout, x-rays, ferros scanning at premium time. Obtain the permission of the Consultant before doing any cutting.

1.23.2 Do all necessary cutting and patching of existing work. X-ray all proposed floor-opening locations prior to core drilling. Refer to Section 20 00 55 – Work in Existing Buildings.

1.23.3 Obtain the Consultant's approval before doing any cutting and patching. Any structural modifications must not affect structural, fire barrier or vapor barrier integrity.

1.24 METALS

1.24.1 Metal construction required for the mechanical work and shown on the Structural Drawings will be carried out by Division 05 – Metals.

1.24.2 Provide all other metal work necessary for the mechanical work, such as, but not limited to, equipment bases, platforms, catwalks, supports, lintels, ladders, pit and trench covers. Have such work carried out in accordance with Division 05 – Metals.

1.24.3 Provide platforms and catwalks complete with safety rails, 6mm (¼") checkered plate or grating cover, suitable for minimum 750mm (30") wide. Provide removable sections where required for equipment removal.

1.24.4 Provide ladders using 13mm by 50mm (½" by 2") steel bar stringers and 19mm (¾") diameter steel bar rungs fastened through and welded to stringers at 300mm (12") on centers. Fabricate ladders 450mm (18") wide and locate 150mm (6") clear of wall face. Secure stringers at top and bottom and at minimum every 1.8m (6 ft) using welded steel brackets.

1.25 CONCRETE

1.25.1 Concrete work required for mechanical work and shown on the structural Drawings will be carried out by Division 03 – Concrete.

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- 1.25.2 Provide all other concrete work specified but not shown on structural Drawings, necessary for the mechanical work including but not limited to inertia slabs, housekeeping pads, and pipe cradles. Have such work carried out in accordance with Division 03 – Concrete.
- 1.25.3 Ensure that the ultimate compressible strength after 28 Days shall not be less than:
- 1.25.4 13,790 kPa (2,000 psi) for pipe encasing and backfill or excessive excavations.
- 1.25.5 20,665 kPa (3,000 psi) for all other work.
- 1.26 EXCAVATION AND BACKFILLING
- 1.26.1 All excavation and backfilling required for the mechanical work will be done under Division 31 – Earthwork of the Specifications, except as noted below. Refer to soil report regarding the type of soil.
- 1.26.2 Ensure that bottom of pipe trench is graded as required.
- 1.26.3 In firm, undisturbed soil, excavation will be carried out under Division 31 – Earthwork, to within 150mm (6") of the bottom of pipes. Excavate under this Division to desired grade, lay pipes directly on the soil and shape soil to fit the lower $\frac{1}{3}$ segment of all pipes and pipe bells. Ensure even bearing along the barrels.
- 1.26.4 In rock and shale and where noted, excavation will be carried out under Division 31 – Earthwork, to 150mm (6") below and minimum 200mm (8") to either side of the pipe. Fill back under this Division, a bedding of 9mm ($\frac{3}{8}$ ") crushed stone or granular 'A' gravel.
- 1.26.5 In unstable soil, in fill and in all cases where pipe bedding has been removed in earlier excavation, particularly near perimeter walls of building and at catch basins, excavation will be carried out to 200mm (8") below the pipe under Division 31 – Earthwork. Compact to maximum possible density under this Division of Work and support the pipe by a 200mm (8") thick concrete cradle spanning full length, between firm supports. Install reinforcing steel in cradle or construct piers at maximum 2400mm (8 ft) spacing. Provide a minimum of one pier per length of pipe, down to solid load bearing strata. Use same method where pipes cross. Do all excavation for such piers.

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- 1.26.6 Provide support over at least the bottom $\frac{1}{3}$ segment of the pipe in all bedding methods.
- 1.26.7 Before backfilling, obtain approval from Consultant.
- 1.26.8 Backfill trenches within the building to a compacted level of 300mm (12") above the top of pipes with clean, sharp sand in individual layers, maximum 150mm (6") thick, hand compacted to a density of 95% Modified Proctor.
- 1.26.9 Backfill trenches outside the building to a compacted level of 300mm (12") above the top of the pipes with individual layers of material up to 150mm (6") thick, hand compacted to a density of 95% Modified Proctor, using Granular 'A' gravel.
- 1.26.10 Obtain written approval of all backfilling done under this Division from Consultant before work commences on additional backfilling under Division 31 – Earthwork.
- 1.27 **PAINTING**
- 1.27.1 Provide all exposed ferrous metal work and Products, except ductwork and piping, with at least one (1) factory prime coat or paint one prime coat on site. Clean up or wire brush all equipment before painting. Unless otherwise noted finish painting will be done under Division 09 – Finishes of these Specifications.
- 1.27.2 If not factory coated or galvanized, clean, wire brush and paint all ferrous supports and hangers concealed in ceiling spaces of kitchens or other similar high humidity areas.
- 1.27.3 Repaint or refinish all damaged factory applied finishes.
- 1.27.4 Provide oil-base red oxide primer applied as per manufacturer's recommendations.
- 1.28 **ABBREVIATIONS**
- 1.28.1 Abbreviations with respect to government agencies, testing agencies, technical societies, approval agencies and technical terminologies are as listed below:

AGA	American Gas Association
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
AMCA	Air Moving and Conditioning Association

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ANSI	American National Standards Institute
API	American Petroleum Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Safety Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BAS	Building Automation System
BC	National or State (US) Building Codes
CGA	Canadian Gas Association
CRN	Canadian Registration Number
CSA	Canadian Standards Association
DDC	Direct Digital Control
ECM	Electronically Commutated Motor
EEMAC	Electrical Equipment Manufacturers Association of Canada
FM	Factory Mutual
IAO	Insurers' Advisory Organization (CGI Information Systems and Management Consultants Inc.)
IEEE	Institute of Electrical and Electronics Engineers
ISTA	International Safe Transit Association
MERV	Minimum Efficiency Reporting Value
MICA	Midwest Insulation Contractors Association
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry

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NBC	National Building Code
NBFU	National Board of Fire Underwriters (currently American Insurance Association)
NC	Noise Criterion
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NPT	National Pipe Thread
OBC	Ontario Building Code
OESC	Ontario Electrical Safety Code
OSHA	Occupational Safety and Health Administration
PID	Proportional–Integral–Derivative
PSC	Permanent-Split Capacitor
PWM	Pulse-Width Modulation
SCR	Silicon Controlled Rectifier
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
TEMA	Tubular Exchanger Manufacturers Association
ULC/cUL	Underwriters' Laboratories of Canada
VAV	Variable Air Volume
VFD	Variable Frequency Drive

1.29 **MANUFACTURER'S CERTIFICATION**

- 1.29.1 Submit letters from the manufacturers of all equipment certifying that their technical representatives have inspected and tested their equipment, have approved the methods of installation and operation. Where existing systems are extended, provide letters covering both new and existing equipment and connections.
- 1.29.2 These letters shall state the names of persons present at the inspection and testing, methods used and a list of functions performed with location and room numbers where applicable.
- 1.29.3 Refer to the respective equipment sections for requirements for

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letters.

1.30 TRIAL USAGE

1.30.1 The Owner has the privilege of the trial usage of mechanical systems or parts thereof for the purpose of testing and learning the operational procedures.

1.30.2 Carry out the trial usage over a length of time as deemed reasonable by the Consultant, at no extra cost.

1.30.3 Carry out the operations only with the express knowledge and under supervision of the Contractor and/or appropriate Subcontractors who shall not waive any responsibility because of trial usage.

1.30.4 Trial usage shall not be construed as acceptance by the Owner.

1.31 INSTRUCTION TO OWNER

1.31.1 Instruct the Owner's representatives in all aspects of the operation of systems and equipment. Refer to requirements for demonstration in respective equipment sections.

1.31.2 Arrange for, and pay for services of service engineers and other manufacturer's representatives required for instruction on specialized portions of the installation.

1.31.3 Submit to the Consultant at the time of final inspection a complete list of systems stating for each system:

1.31.3.1 Date instructions were given to the Owner's staff.

1.31.3.2 Duration of instruction.

1.31.3.3 Names of persons instructed.

1.31.3.4 Other parties present (manufacturer's representative, consultants, etc.).

1.31.3.5 Signatures of the Owner's staff stating that they properly understood the system installation, operation and maintenance requirements.

1.32 EARLY OCCUPANCY

1.32.1 The Owner will negotiate with the Contractor to occupy portions of

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the building before the Work is complete. Sufficient advance notice will be given to allow scheduling of the mechanical work to meet the Owner's requirements.

- 1.32.2 Notify the Contractor of any scheduling problems.
- 1.32.3 Schedule the Work and set construction priorities to satisfy the Owner's requirements.
- 1.32.4 Schedule the Work of this Division as follows:
 - 1.32.4.1 Relevant equipment is ready for start-up as defined in these Specification Sections.
 - 1.32.4.2 Systems are balanced.
 - 1.32.4.3 Safety controls are in place.
 - 1.32.4.4 Automatic temperature controls are operational.
 - 1.32.4.5 Primary equipment is tested and started-up.
 - 1.32.4.6 All filters are in place.
- 1.32.5 The Owner will take over individual items of equipment used for Early Occupancy and the warranty period will start when:
 - 1.32.5.1 Conditions of start-up (Item 1.32.4) have been complied with.
 - 1.32.5.2 Air and fluid systems have been balanced.
- 1.32.6 The Consultant will issue a list of deficiencies covering the individual items of equipment used for Early Occupancy at the time of takeover by the Owner.
- 1.32.7 Early Occupancy and the Owner's takeover of individual items of equipment does not relieve the Contractor of their responsibility to test, adjust, balance, commission and demonstrate the systems in accordance with the Contract Documents.
- 1.33 **OPERATION AND MAINTENANCE MANUALS**
 - 1.33.1 Assemble three (3) manuals, each containing data sheets, brochures, operating, maintenance, recommended spare parts, and lubricating instructions and a complete set of reviewed shop drawings and bind in hard cover. Identify cover "Operation and Maintenance Manual for FIFA – East VSTS". Manuals shall be

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separated with dividers in logical sections and volumes.

- 1.33.2 Present one (1) copy for review by Consultant. Make all corrections requested by the Consultant and forward the corrected review copy plus a duplicate to the Owner with a copy of transmittal to Consultant for their records. Include the following information in each manual:
 - 1.33.2.1 Refrigeration Equipment
 - 1.33.2.1.1 Operating instructions detailing the procedures to be followed for:
 - Charging
 - Start-up
 - Changeover from one season to another
 - Shutdown
 - Night operation
 - Maintenance instructions
 - 1.33.2.1.2 Lubrication instruction for moving parts detailing type of lubricant to be used and the lubrication intervals in operation hours.
 - 1.33.2.1.3 List of safety devices and instructions for their testing and adjusting.
 - 1.33.2.1.4 Complete set of shop drawings showing:
 - Control sequence with description of the sequences of operation.
 - Detailed layout and sections indicating all maintenance, cleaning and lubrication points.
 - 1.33.2.1.5 List of parts (bill of material) indicating the catalogue number and manufacturer, complete with drawings indicating the location of each part in the complete assembly.
 - 1.33.2.1.6 Recommended chemical analysis of chilled water.
 - 1.33.2.2 Heat Exchangers and Coils
 - 1.33.2.2.1 Equipment layout (plans and section) giving all information on type of flanges, bolts, nuts, studs, tubes, etc.
 - 1.33.2.2.2 Tube replacement instructions.

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- 1.33.2.2.3 Cleaning instructions.
- 1.33.2.3 Pumps and Fans. Include for each different type and size:
 - 1.33.2.3.1 Shop drawings indicating maintenance and lubrication points.
 - 1.33.2.3.2 List of parts indicating the catalogue number and manufacturer, complete with drawings indicating the location of each part in the complete assembly.
 - 1.33.2.3.3 Performance curves.
- 1.33.2.4 Valves and Fittings
 - 1.33.2.4.1 Three (3) copies of framed valve charts for the project.
 - 1.33.2.4.2 A list of valves as per the valve chart indicating size, type, catalogue number, make of each valve, strainer and steam trap.
- 1.33.2.5 Instrumentation and Control
 - 1.33.2.5.1 Complete instrument list for all gauges, thermometers, gauge glasses and other instruments.
 - 1.33.2.5.2 Sequence and description of operation for each control system.
 - 1.33.2.5.3 Control diagram for each system complete with equipment summary giving system designation and catalogue number for each component.
 - 1.33.2.5.4 Catalogue leaflet of each component used.
 - 1.33.2.5.5 Applications programming information and programmer's manual.
 - 1.33.2.5.6 Description of operating procedures, including required actions at each operator position, operation of computer peripherals, input and output formats and procedures, and emergency alarm and failure recovery procedures. Descriptions of system start-up, back-up equipment operation, and execution of all system functions and operating modes shall be provided.
 - 1.33.2.5.7 Provide description of data communication, including data types and formats, data link components and interfaces, and operator test.
 - 1.33.2.5.8 Instructions and schedules for inspections, cleaning, lubricating and calibration.

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- 1.33.2.6 Other Equipment
 - 1.33.2.6.1 Description of start-up and activating procedures, and commissioning procedures, as well as follow-up instructions to the Owner's operating staff to slowly break-in unit.
 - 1.33.2.6.2 Maintenance instructions for all other equipment containing moving parts or requiring lubrication or chemical charging.
 - 1.33.2.6.3 Include instruction list of parts indicating catalogue number and manufacturer, complete with drawings indicating the location of each part in the complete assembly; performance curves.
 - 1.33.2.7 A list of all motors serving mechanical equipment. Include in the list:
 - 1.33.2.7.1 Location of motor.
 - 1.33.2.7.2 Name of unit served by motor.
 - 1.33.2.7.3 Motor serial number, manufacturer.
 - 1.33.2.7.4 Power rating, voltage, full load current, service factor and rpm of motor (nameplate data), rating and catalogue number of motor starter thermal overload relays.
 - 1.33.2.7.5 Serial number, rpm, airflow, manufacturer, static pressure (or head) of fan or pump.
 - 1.33.2.7.6 Quantity, sizes and V-belt number of belts.
 - 1.33.2.7.7 Sizes and types of drives used.
 - 1.33.2.7.8 Type of oil or grease lubrication of gearbox, lubrication interval in hours of operation.
 - 1.33.2.7.9 Type of grease lubrication for driven equipment, lubrication interval in hours of operation.
 - 1.33.2.8 A copy of the following:
 - 1.33.2.8.1 All reviewed sprinkler layouts and hydraulic calculations.
 - 1.33.2.8.2 Final NFPA certification letter. Certification letter shall contain contractor's contact information, the building permit number, certification statement in regard to NFPA compliance and be stamped by a licensed professional engineer.

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- 1.33.2.8.3 Certificates from all equipment manufacturers, duct-cleaning agents, pipe-cleaning agents, chemical treatment agents and local authorities having jurisdiction.
- 1.33.2.8.4 All pipe and duct pressure test reports.
- 1.33.2.8.5 Warranties and letters of guarantee from contractors and equipment manufacturers.
- 1.33.2.8.6 Copies of permits, licenses and certificates.
- 1.33.2.8.7 Start-up and activation and commissioning procedures and check sheets.
- 1.34 WARRANTY
- 1.34.1 Refer to General Conditions of the Contract and Specimen Warranty Form.
- 1.34.2 Furnish all extended warranty for equipment as required in the Specifications.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Provide Shop Drawings for:

1.2.1.1 Access doors and panels.

1.3 MATERIALS AND EQUIPMENT

1.3.1 Use only new materials and equipment of Manufacturer as specified or shown on the Drawings. Ensure that equipment and materials for similar applications are of the same Manufacturer.

1.3.2 If the Subcontractor wishes to substitute materials of Manufacturers other than those named, they shall state in their Tender the name and a complete description of the materials to be substituted, along with the amount of change in the Contract Price.

1.3.3 Ensure that materials not specified to a specific Manufacturer are of high commercial standard and quality.

2 **PRODUCTS**

2.1 ACCESS DOORS AND PANELS

2.1.1 In plaster, gypsum board, tiled or masonry walls for exposed flush installation, provide 203mm by 203mm (8" x 8") prime coated 16 ga. access door with 18 ga. mounting frame, continuous concealed hinge, and screwdriver operated stainless steel cam latch, similar to Acudor UF-5000.

2.1.2 In plaster or tiled walls for recessed installation, provide 305mm by 305mm (12" x 12") 16 ga. access door recessed by 25mm (1"). Door to be complete with 14 ga. mounting frame, concealed pivoting rod type hinge, and flush-to-surface screwdriver operated stainless steel cam latch, similar to Acudor AT-5020.

2.1.3 In gypsum board surfaces or in acoustic tiles for recessed installation in public areas, provide 305mm by 305mm (12" x 12") bauco-plus architectural access door with concealed hardware and gypsum board inlay. Standard features include cam latch flush

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with surface, aluminum frame and glass fibre-reinforced nylon hardware, fully hinged removable door panel and integrated safety catches, perimeter gasket installed onsite.

2.1.3.1 In areas not accessible by public, provide 305mm by 305mm (12" x 12") 16 ga. access door recessed by 25mm (1"). Door to be complete with 14 ga. mounting frame with drywall taping bead on all sides, concealed pivoting rod type hinge, and flush-to-surface screwdriver operated stainless steel cam latch, similar to Acudor DW-5015.

2.1.4 In fire rated walls, provide 305mm by 305mm (12" x 12") 16 ga. rated access door, ULC listed "B" label for 1-1/2 or 2 hours. Door to be complete with 16 ga. mounting frame, concealed hinge, spring closer, and knurled knob operated universal self-latching bolt, similar to Acudor FB-5060.

2.2 BEARINGS AND GEAR BOXES

2.2.1 Provide bearings suitable for application and environment, i.e., dust, corrosive atmospheres, high temperatures, etc. Bearings shall have a lifetime guarantee of not less than five (5) years.

3 **EXECUTION**

3.1 FLASHING

3.1.1 Provide galvanized or aluminum sleeves for piping through roof.

3.1.2 Ensure that the flashing suits roof and extends minimum 450mm (18") on all sides. Leave flashing as directed by the Contractor, to be built into roofing, rendering a watertight connection.

3.1.3 Provide counter flashing on diesel and boiler exhaust stacks, ducts, and pipes passing through roofs to fit over flashing or curb. Coordinate with the Subcontractor responsible for the roofing work of the Contractor.

3.1.4 Sleeve pipes through waterproof floors.

3.1.5 Pay special attention to the waterproofing conditions of basement walls and floors. Co-operate at all times with the water proofing trade and do not cut or destroy any waterproofing seal without the consent of the waterproofing trade. Provide piping sleeves passing through waterproof walls with asphalt roofing felt wrapped around to leave 25mm by 50mm (1" x 2") recess on both sides of the wall.

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These recesses and the space between pipe and sleeve shall be caulked by this Division in accordance with the requirements of Division 07 – Thermal and Moisture Protection.

3.2 BEARINGS AND GEAR BOXES

3.2.1 Run-in all bearings, gearboxes and fluid couplings for a period recommended by the manufacturer. Flush out, and refill with new charge of recommended lubricant.

3.2.2 Provide all necessary lubricating materials and labour for all operating equipment until acceptable for operation and care by the Owner.

3.2.3 Provide oil-lubricated bearings and sumps with level gauge, in easily accessible location. Provide grease-lubricated bearings, if not readily accessible, with extended nipples.

3.3 BELT DRIVES, SHEAVES AND GUARDS

3.3.1 Provide all belt-driven equipment with V-belt drive, designed for at least 130 percent of motor nameplate power rating, and in accordance with manufacturer's recommendations for type of service intended. Belt drives to be at least 95 percent efficient. Balance and properly align drives. Provide matched sets of belts for multiple belt assemblies. Select belts to suit starting torque for driver. Use single belt drives only for motors 1.5kW (2.0 HP) and smaller.

3.4 INSERTS, SLEEVES, ESCUTCHEONS AND CURBS

3.4.1 Use only factory made, threaded, or toggle type inserts as required for supports and anchors, properly sized for the load to be carried. Place inserts only in portions of the main structure and not in any finishing material.

3.4.2 Use factory made expansion shields where inserts cannot be placed, but only where permission is given by the Consultant.

3.4.3 Do not use powder-activated tools except with written permission from the Consultant.

3.4.4 Supply and locate inserts, holes, anchor bolts, and sleeves in time when walls, floors and roof are erected.

3.4.5 Sleeves shall be concentric with pipe and be a minimum of 50mm (2") larger than pipe size.

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- 3.4.6 Pass insulation unbroken where pipe or duct is insulated, except through fire rated walls and floors. Size sleeves to provide 13mm ($\frac{1}{2}$ ") clearance all around.
- 3.4.7 Use the following sleeving material for pipe sleeves:
 - 3.4.7.1 Through interior walls use Schedule 10 steel pipes, machine cut, flush with finished structure. Check room-finish schedules.
 - 3.4.7.2 Through exterior walls above grade use Schedule 10 steel pipes, machine cut, flush with finished structure inside and to suit flashing on outside.
 - 3.4.7.3 Through exterior walls below grade and other waterproof walls use extra heavy weight cast iron or PVC sleeves, machine cut. Check flashing details for further information.
 - 3.4.7.4 Through waterproof floors, through janitor's closets, mechanical rooms, compartment mechanical rooms, showers, kitchens, washrooms, and through roofs, use Schedule 40 sleeves, machine cut. As an alternative, copper DWV sleeves up to and including 150mm (6") sleeve size and rolled 32 ounce copper sleeves for larger than 150mm (6") sleeve size may be used. Extend sleeves 100mm (4") above finished floor upwards and cut flush with underside of floor. Refer to flashing details through waterproof floors.
 - 3.4.7.5 Through other interior floors use Schedule 10 steel pipes, machine cut, flush with finished structure on both sides. Check room-finish schedules for further information.
 - 3.4.7.6 Ensure that watertight concrete curbs, 100mm (4") high by 100mm (4") wide with 19mm ($\frac{3}{4}$ ") chamfered edges, are furnished around pipes passing through waterproof floors except where furred in. Read Division 03 – Concrete for further information.
- 3.4.8 Pack spaces between the insulated pipe and the sleeve or where uninsulated, between the pipe and the sleeve, with ULC listed fire rated foam. Maintain vapour barrier on cold lines. Seal the annular space both sides as follows:
 - 3.4.8.1 For horizontal sleeves in exposed areas, use a seal equal to or better fire rated than the wall to be sealed. Use "Fire barrier" as distributed by Double A/D Distributors Ltd. (UL No. 4 U 18.7 approved).

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- 3.4.8.2 For horizontal concealed sleeves through firewalls and through walls separating areas of different air pressure, use a permanently resilient (silicone base or equal) sealing compound.
- 3.4.8.3 For vertical sleeves through roofs, janitor's closets, equipment rooms, and where required to provide fire rated separation, use permanently resilient (silicone base or equal) sealing compound, non-flammable and waterproof. Ensure that the seal is compatible with floor and ceiling finishes. Check the room-finish schedules for further information.
- 3.4.8.4 All fire stop materials and methods must be approved in accordance with CAN/ULC-S115-11, and be ULC listed.
- 3.4.8.5 Seal is not required for other sleeves.
- 3.4.9 Cover exposed floor and wall pipe sleeves in finished areas with satin finish chrome or nickel plated solid brass or with satin finish stainless steel escutcheons with non-ferrous set screws. Split cast plates of the screw locking type may be used. Do not use stamped steel friction type split plates.
- 3.4.10 Use the following sleeving for ducts:
 - 3.4.10.1 Unless otherwise noted, use minimum 1.3mm (18 gauge) galvanized steel sleeves.
 - 3.4.10.2 For rectangular duct openings through walls and floors provide a removable wood box-out of the required size.
 - 3.4.10.3 Through firewalls, build fire dampers into wall.
 - 3.4.10.4 Through floors where ducts are not furred in or enclosed in a duct-shaft, ensure the 100mm (4") high by 100mm (4") wide watertight concrete curbs are provided, with 19mm ($\frac{3}{4}$ ") chamfered edges all around. Extend sleeves where used, flush to top of curb. Read Division 03 – Concrete, for further information.
 - 3.4.10.5 Through floors where ducts are enclosed in a duct shaft or furred in, provide the watertight concrete curbs at the extreme top and bottom ends of the shaft only.
 - 3.4.10.6 Through roofs, provide curbs and sleeves as shown on the detail drawings and to suit flashing requirements.
- 3.4.11 After ducts are installed, pack the opening and seal both sides as follows:

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- 3.4.11.1 Use fiberglass insulation for packing, except through curbed concrete floors use "Fire barrier" as distributed by Double A/D Distributors Ltd. (UL No. 4 U 18.7 Approved).
- 3.4.11.2 Seal the packing in openings through floors with permanently resilient (Silicone base or equal) compound, non-flammable and waterproof. Press duct supports firmly into caulking before bolting down to curb.
- 3.4.11.3 Through all vertical walls seal the fibreglass packing using a permanently resilient (silicone base or equal) sealing compound.
- 3.4.11.4 All fire stop materials and methods must be approved in accordance with CAN/ULC-S115-11, and be ULC listed.
- 3.4.11.5 Seal is not required for other packings.
- 3.4.12 Brace duct sleeves and box-outs to retain their position and shape during the pouring of concrete and other work.
- 3.4.13 Provide bracing for each duct at every passing through structure to prevent sagging.
- 3.4.14 Cover exposed duct sleeves and openings in exposed areas only. Use 1.3mm (18 gauge) galvanized steel escutcheons in form of a duct collar. Over curbs extend the collar 25mm (1") down the side of the curb, similar to counter flashing. Fix collar in position with cadmium plated screws.
- 3.5 **ACCESS DOORS AND PANELS**
- 3.5.1 Install all concealed mechanical equipment requiring adjustment or maintenance in locations easily accessible through access panels or doors. Install systems and components to result in a minimum number of access panels. Indicate access panels on "As Built" drawings.
- 3.5.2 Provide the work of respective Division with panels, doors or the frames therefore; complete with all pertinent information for installation. Arrange with and deliver to the Subcontractor(s) in whose work they occur to install them. Ensure that access doors are installed in a manner to match the building material grids where applicable.
- 3.5.3 Prepare detailed and coordinated drawings showing location and type of all access doors. Submit these drawings to the Consultant

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to review.

3.5.4 Size all access doors to provide adequate access and commensurate with the type of structure and architectural finish, minimum size 150mm (6") by 150mm (6). Should it be necessary for persons to enter, provide a minimum 600mm (24") by 450mm (18") size doors.

3.5.5 Ensure proper fire rating of access doors in fire separations, fire-rated walls and ceilings.

3.5.6 Lay-in type tiles, properly marked, may serve as access panels.

3.6 DRIP PANS

3.6.1 Construct drip pans of min. 1.0mm (20 gauge) galvanized steel sheet with sealed connections. Provide drain lines from drip pans to nearest hub drain, funnel floor drain, janitor's sink or appropriate approved location.

3.6.2 Provide drip pans at the following locations:

3.6.2.1 Beneath all pipes and heat pumps passing through electrical, battery, UPS, elevator machine, diesel generator, and telephone rooms, over horizontal runs of bus ducts, and in locations as indicated on the Drawings.

3.7 WORKMANSHIP

3.7.1 Install ducts and pipes parallel and perpendicular to the building planes and concealed in chases, behind furring or above ceiling, except in unfinished areas. Install all exposed systems neatly and group together, to present a neat appearance.

3.7.2 Install all equipment and apparatus requiring maintenance, adjustment, or replacement with sufficient clearance for servicing.

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Electric Motors**
Section No.: **20 05 13**
Date: November 8, 2024

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Project No.: 2024-0112
Section Name: **Electric Motors**
Section No.: **20 05 13**
Date: November 8, 2024

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

2 **PRODUCTS**

2.1 MOTORS

2.1.1 Supply and install all motors for Mechanical Equipment.

2.1.2 All motors shall be 60 cycle, 1750 rpm, except where noted otherwise.

0.37kW ($1/2$ HP) and smaller: 120V, 1 Ph, 60 Hz.

0.56kW ($3/4$ HP) and larger: 575V, 3 Ph, 60 Hz.

2.1.3 Motors shall be squirrel-cage induction motors, built to CEMA and NEMA motor and generator standards. 2-speed motors shall be single winding variable torque.

2.1.4 The minimum requirement for three phase motors shall be CEMA Design B; Class B insulated for maximum 40°C (104°F) ambient.

2.1.5 Single-phase motors shall be capacitor types, for minimum 10 starts per hour.

2.1.6 Motors 44.7kW (60 HP) and over shall be with inherent overheat protection, consisting of thermistors embedded in each phase of the stator winding and wired to the motor conduit box.

2.1.7 Select motors for quiet, continuous operation to suit loads, which may be imposed by equipment. Recognize that motor powers specified and scheduled are minimum sizes. If larger motors are required, ensure that extra costs of larger motors, starters, power wiring, and additional control wiring are included in the work.

2.1.8 All motor 0.75kW (1 HP) to 373kW (500 HP), unless otherwise specified, shall be T-frame AC three phase, and equal or exceed the motor efficiency levels as tested to CSA-C390-M or the nominal efficiency noted in Tables 10.4.1.A.(a) or 10.4.1.A.(b) of SB-10 of the OBC (premium efficiency/energy efficient), whichever is the highest. Motors to be approved under Canadian Electrical Safety Code.

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- 2.1.9 Motor enclosures shall be as follows:
- 2.1.9.1 If protected from the weather and entraining moisture, use open drip-proof, service factor 1.15.
- 2.1.9.2 Motors located in air streams shall be selected to operate satisfactorily at maximum temperature and moisture levels of surrounding air. Use drip-proof motors with encapsulated windings and weatherproof terminal box.
- 2.1.9.3 For all other locations, use totally enclosed fan-cooled, service factor 1.0.
- 2.1.9.4 Use explosion-proof motors where scheduled.
- 2.1.10 All motors shall be fitted with sealed for life bearing requiring no periodic lubrication.
- 2.1.11 Submit an accurate schedule of all motors. Include for each motor, the motor capacity, speed, nameplate current, equipment served, location, electrical characteristics, and identification number.
- 2.1.12 Provide each motor with a terminal box sized to accommodate the conductors connected thereto. Locate the terminal box to face the outside of the equipment assembly.
- 2.1.13 Provide EEMAC adjustable sliding bases for motors used with belt drives.
- 2.1.14 All motors driven by Variable Frequency Drives (VFD's) shall be NEMA31 design, have class F insulation, and be rated for inverter duty. Refer to Section 20 09 49 – Variable Frequency Drives.

3 **EXECUTION**

Not Used.

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Electrical Wiring**
Section No.: **20 05 14**
Date: November 8, 2024

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Project No.: 2024-0112
Section Name: **Electrical Wiring**
Section No.: **20 05 14**
Date: November 8, 2024

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Division 26 - Electrical will do all power wiring for equipment provided by Divisions 21, 22, 23 and 25.

1.2.2 Divisions 21, 22, 23 and 25 shall provide all disconnect switches for mechanical equipment as required by code. Provide weatherproof switches for all outdoor locations.

1.2.3 Field control wiring of local safeties and interlocks for packaged equipment shall be provided under the respective Sections unless otherwise specified.

1.2.4 Conduit and wiring materials and methods shall be in strict accordance with the requirements of Division 26 - Electrical.

1.2.5 Check all wiring diagrams and control diagrams submitted in shop drawing form. Before submitting these shop drawings to the Consultant, submit these drawings to Division 26 - Electrical Contractor for approval. Have these drawings stamped by Division 26 - Electrical Contractor as verification of their approval before forwarding to the Consultant. Co-operate in the commissioning of all electrically driven equipment with Division 26 - Electrical.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Conduit and wiring materials and methods shall be in strict accordance with the requirements of Division 26 - Electrical.

3 **EXECUTION**

3.1 GENERAL

3.1.1 Refer to Division 26 - Electrical.

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END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Electrical Ancillaries**
Section No.: **20 05 15**
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Project No.: 2024-0112
Section Name: **Electrical Ancillaries**
Section No.: **20 05 15**
Date: November 8, 2024

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Contactors and control devices.

1.3 SUBMITTALS

1.3.1 Submit Shop Drawings for:

1.3.1.1 Contactors and control devices.

1.4 ELECTRICAL EQUIPMENT AND WORK

1.4.1.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus that is required and is not covered by Division 26 – Electrical.

2 **PRODUCTS**

Not Used.

3 **EXECUTION**

3.1 CONTACTORS AND CONTROL DEVICES

3.1.1 Install all automatic devices such as thermostats, controlling electrical equipment, supplied under this Division.

3.1.2 Disconnect switches, starters, push button stations, cable lugs, pilot lights, and control circuit transformers shall be supplied and installed by Division 26 – Electrical, except as noted below.

3.1.2.1 Division 21, 22 and 23 shall provide all starters, contactors, fuses, etc., for packaged equipment such as chillers, boilers, domestic hot water heaters, rooftop air conditioning and heating units, electric reheat coils, computer room air conditioning units, etc., as specified in the respective sections. Division 26 – Electrical shall

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provide disconnect switches for these equipment as required by applicable code.

- 3.1.3 Provide Division 26 – Electrical Contractor with all details of the motors and electrical equipment supplied for selection of overload protection, etc.

END OF SECTION

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Section Name: **Expansion Compensation**
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Section Name: **Expansion Compensation**
Section No.: **20 05 16**
Date: November 8, 2024

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified herein, including:

1.2.1.1 All necessary expansion compensation elements for piping and equipment.

1.2.2 Manufacturer of expansion compensation equipment shall guarantee specified isolation system deflection.

1.2.3 Manufacturer to provide installation instructions, drawings, and field supervision to assure proper installation and performance.

1.2.4 In addition to the work of this Section, comply with description of individual systems and general requirements of all other Specification Sections of this Division.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for expansion compensation equipment.

1.3.2 As a minimum provide the following information:

1.3.2.1 Catalogue cuts and data sheets on specific compensators to be utilized showing compliance with the Specifications.

1.3.2.2 Drawings showing methods of suspension, support guides for piping and ductwork. Submittals must include the initial load, initial deflection, change in deflection, final load and change in load at all spring and anchor support locations, as well as guide spacing. Calculations shall include pipe stress at end conditions and branch off locations and the manufacturer must include installation instructions.

1.3.3 Submittal must be stamped and signed by a licensed professional engineer, either in the employ of the expansion compensation vendor or specialized to the field of expansion compensation system design, for at least 5 years.

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1.3.4 Submit letter from manufacturer certifying that expansion compensation equipment have been installed in accordance with its recommendations and the Contract Documents, and that it operates to their satisfaction.

1.4 QUALITY ASSURANCE

1.4.1 All grooved joint couplings and specialties shall be the products of a single manufacturer.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All expansion compensation devices shall be the product of a single manufacturer.

2.2 EXPANSION COMPENSATORS

2.2.1 Provide manufactured expansion joints suitable for working and test conditions of the pipe in which they are installed, with adequate cyclic life to last through 25 years of normal operation. Select the joints for the expected movement in the temperature ranges from 4.4°C (40°F) to maximum operating temperature plus 25% for hot pipes and from 26.6°C (80°F) to minimum operating temperature plus 25% for cold pipes.

2.2.2 Rubber expansion joints shall be peroxide cured EPDM throughout with Kevlar tire cord reinforcement. Substitutions must have certifiable equal or superior characteristics. The raised face rubber flanges must encase solid steel rings to prevent pull out. Flexible cable wire is not acceptable. Sizes 40mm through 350mm (1-1/2" through 14") shall have a ductile iron external ring between the two spheres. Sizes 400mm to 600mm (16" through 24") may be single sphere. Sizes 20mm through 50mm (3/4" through 2") may have one sphere, bolted threaded flange assemblies and cable retention.

2.2.2.1 Minimum ratings through 350mm (14") shall be 1.72MPa at 77°C and 1.48MPa at 121°C (250psi at 170°F and 215psi at 250°F), 400mm (16") through 600mm (24") 1.24MPa at 77°C and 1.03 MPa at 121°C (180psi at 170°F and 150psi at 250°F). Higher published rated connectors may be used where required.

2.2.2.2 Control rods passing through 12mm (1/2") thick Neoprene washer bushings large enough to take the thrust at 0.7 kg/mm² (1000 psi)

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of surface area may be used on unanchored piping where the manufacturer determines the condition exceeds the expansion joint rating without them.

- 2.2.2.3 Expansion joint to achieve a minimum reduction of 20 dB in vibration accelerations and 10 dB in sound pressure levels at typical blade passage frequencies.
- 2.2.2.4 Safety factors shall be a minimum of 3/1. All expansion joints must be factory tested to 150% of maximum pressure for 12 minutes before shipment.
- 2.2.2.5 Rubber expansion joint to be Mason Type SAFEFLEX SFDEJ, SFEJ, SFDJR or SFU, control rods Type CR.
- 2.2.3 Provide braided hose type connectors in accordance with the following schedule.
- 2.2.3.1 Low pressure service up to 121°C (250°F): bronze hose and copper sweat connection up to 65mm (2-½") dia., Mason Type CPSB; 304 stainless steel hose and carbon steel flanged connection 80mm (3") dia and up, Mason Type FFL.
- 2.2.3.2 Medium pressure service up to 121°C (250°F): 304 stainless steel hose and carbon steel threaded nipple up to 65mm (2-½") dia., Mason Type MN, 304 stainless double-braided steel hose and carbon steel flanged connection 80mm (3") dia and up, Mason Type FFL-2B300.

Size I.D.	Operating Pressure Low	Length	Max. Lateral Offset	Operating Pressure Medium	Length	Max. Lateral Offset
mm (in.)	kPa (psi)	mm (in.)	mm (in.)	kPa (psi)	mm (in.)	mm (in.)
20 (¾")	1,793 (260)	450 (18")	63 (2-½")	2,944 (427)	450 (18")	88 (3-½")
25 (1")	1,717 (249)	450 (18")	56 (2-¼")	2,434 (353)	450 (18")	75 (3")
32 (1-¼")	1,689 (245)	450 (18")	44 (1-¾")	2,117 (307)	450 (18")	56 (2-¼")
40 (1-½")	1,413 (205)	600 (24")	88 (3-½")	1,841 (267)	450 (18")	50 (2")
50 (2")	992 (144)	600 (24")	81 (3-¼")	1,517 (220)	600 (24")	94 (3-¾")
65 (2-½")	972 (141)	600 (24")	50 (2")	1,241 (180)	600 (24")	75 (3")
80 (3")	1,193 (173)	450 (18")	50 (2")	1,586 (230)	300 (12")	19 (¾")
100 (4")	965 (140)	450 (18")	38 (1-½")	1,586 (230)	450 (18")	32 (1-¼")
150 (6")	875 (127)	600 (24")	50 (2")	1,586 (230)	450 (18")	22 (7/8")

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Size I.D.	Operating Pressure Low	Length	Max. Lateral Offset	Operating Pressure Medium	Length	Max. Lateral Offset
mm (in.)	kPa (psi)	mm (in.)	mm (in.)	kPa (psi)	mm (in.)	mm (in.)
200 (8")	875 (127)	600 (24")	38 (1-½")	992 (144)	600 (24")	32 (1-¼")
250 (10")	738 (107)	600 (24")	32 (1-¼")	889 (129)	600 (24")	28 (1-⅛")
300 (12")	738 (107)	600 (24")	25 (1")	717 (104)	600 (24")	22 (7/8")

2.2.4 When bellows type expansion joints are used:

2.2.4.1 For pipes DN100 (4") and smaller provide two-ply stainless steel bellows type expansion compensator complete with anti-torque device, limit stops, internal guides with male IPT ends (Flexonics Type H). For copper pipes, two-ply bronze bellows (Flexonics Type HB) may be used.

2.2.4.2 For pipes DN150 (6") and larger provide single or double externally pressurized type expansion joints (Flexonics Type SX/NDX) with multiply 304 S.S. bellows, self-draining steel shell, integral guide ring, cover and liner. Expansion joint to be leakproof packless type, and maintenance-free. The joint shall be used to compensate for axial movement only.

2.2.5 Grooved end expansion joints:

2.2.5.1 For pipe sizes DN50 (2") through DN150 (6") provide a packless, gasketed, telescoping expansion joint consisting of a carbon steel body and slide section, and Victaulic couplings. Slide section to be coated with PTFE modified PPS coating. Joint shall be suitable for axial end movement up to 88.9mm (3"). Victaulic Mover Style 150.

2.2.5.2 For pipe sizes DN20 (¾") through DN300 (12") provide a joint consisting of a series of grooved end pipe spools joined in tandem with Victaulic Style 77 couplings. (The number of nipples/couplings dependent on the movement required.) Victaulic Style 155.

2.2.6 All-directional acoustical pipe anchors shall consist of two sizes of steel tubing separated by a minimum 12mm (½") thickness of 60 duro or softer neoprene. Vertical restraint shall be provided by similar material arranged to prevent up or down vertical travel. Allowable loads on the isolation material shall not exceed 3.45

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N/mm² (500 psi) and the design shall be balanced for equal resistance in any direction. All-directional anchors shall be Mason Type ADA.

- 2.2.7 Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 12mm (1/2") thickness of 60 durometer or softer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Guides shall be capable of ∇ 40mm (1-5/8") motion, or to meet location requirements. Pipe guides shall be Mason Type VSG.
- 2.2.8 Thrust restraint shall consist of a modified Type A spring mounting. Restraint springs shall have the same deflection as the isolator springs. The assembly shall be pre-set at the factory and fine-tuned in the field to allow for a maximum of 6mm (1/4") movement from stop to maximum thrust. The assemblies shall be furnished with rod and angle brackets for attachment to both the equipment and duct work or the equipment and the structure. Restraints shall be attached at the center line of thrust and symmetrically on both sides of the unit. Horizontal, vertical and diagonal thrust restraints shall be Mason Type WB.
- 2.2.9 Wall, floor and ceiling acoustical seals shall be split seals consisting of pipe halves with minimum 20mm (3/4") thick neoprene sponge cemented to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not in place prior to the construction of the building member. Seals shall project a minimum of 25mm (1") past either face of the wall. Where temperatures exceed 115°C (240°F), 160 kg/m³ (10 lb) density fiberglass may be used in lieu of the sponge. Seals shall be Mason Type SWS.

3 EXECUTION

3.1 GENERAL

- 3.1.1 Install compensators in accordance with manufacturer's written instructions. Compensators must not cause any change or position of equipment or piping resulting in piping stresses or misalignment.

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3.2 EXPANSION COMPENSATION

- 3.2.1 Provide all necessary expansion joints or loops to control all piping movement without imposing undue stress onto structure, apparatus, or piping systems.
- 3.2.2 All compensators shall be installed on the equipment side of the shut off valves.
- 3.2.3 Where possible, use loops or swing joints. Where loops or swing joints cannot be used due to space limitations and where shown, provide a manufactured expansion joint in accordance with the manufacturer's instructions, complete with all the necessary anchors and guides.
- 3.2.4 For water systems with grooved joints, use adequate numbers of Victaulic Style 77 or 177H flexible couplings in header piping to accommodate thermal growth and contraction, and elimination or reduction of expansion loops. Where expansion loops are required, use Victaulic Style 77 or 177H couplings on the loops.
- 3.2.5 In all branch piping to radiation, perimeter units, booster coils, unit heaters, cabinet unit heaters and risers, provide swing joints or braided hose connectors. Provide braided hose type in all connection joints in all connections to equipment where shown in the Contract Documents.
- 3.2.5.1 Three (3) Victaulic Style 77 or 177H flexible couplings may be used in equipment drops in lieu of braided-hose flexible connectors for stress relief and vibration attenuation. The couplings shall be placed in close proximity to the source of the vibration.
- 3.2.6 Where braided hose type connectors are installed, anchor or guide pipes to eliminate all weight onto connectors. Use braided hose type joints for lateral movement only. Select the length of hose to manufacturer's instructions.
- 3.2.7 For bellows type expansion joints adjust end fittings to suit pipe application.
- 3.2.8 Until all pressure leakage tests are complete in all piping systems, install steel spools instead of flexible connections.

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3.3 MANUFACTURER'S REVIEW

- 3.3.1 On completion of installation of all expansion compensation devices herein specified, the manufacturer shall inspect the completed system, and report in writing any installation error, improperly selected devices, or other faults in the system that could affect the performance of the system. A written report shall be submitted outlining corrective work necessary to comply with the above specifications. Corrective work shall be the responsibility of the respective installing Subcontractor (Division 21, 22 or 23).

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Meters and Gauges**
Section No.: **20 05 19**
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Project No.: 2024-0112
Section Name: **Meters and Gauges**
Section No.: **20 05 19**
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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Temperature gauges

1.2.1.2 Pressure gauges

1.3 SHOP DRAWINGS

1.3.1 Submit Shop Drawings for the following equipment:

1.3.1.1 Temperature gauges

1.3.1.2 Pressure gauges

2 **PRODUCTS**

2.1 TEMPERATURE GAUGES

2.1.1 Provide thermometers of 229mm (9") straight shank, immersion type, with red liquid fill and adjustable pivot, installed complete with non-ferrous separable well. Provide 150mm (6") long extension neck socket for insulated pipes. Thermometers with plastic case are not acceptable.

2.1.2 Select all thermometers to suit the expected range of temperatures of the medium and ensure that normal working temperature occurs approximately at mid-scale.

2.2 GAUGE GLASSES

2.2.1 Provide gauge glasses on all liquid reservoirs, normally not completely filled.

2.2.2 Provide fail-safe type gauge glasses with shut off valve, ball check, flushing facilities, and white enamelled brass backplates, suitable for the intended service.

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2.2.3 Provide gauge glasses complete with tri cocks. Extend tank gauge glasses the full tank height, if necessary through use of multiple gauge glasses in staggered arrangement.

2.3 PRESSURE GAUGES

2.3.1 Provide pressure gauges of the Bourdon type, minimum one percent accuracy through the entire range, complete with bronze Bourdon tube, brass socket, brass rotary movement, bronze bushings, tube and movement independently mounted from case, stainless steel case and ring, inherent shock protection. Furnish gauges having 114mm (4-½") dial, black graduations, black case, silver brazed joints, and adjustable black pointer.

2.3.2 Select gauges to suit fluid working pressure and, if possible, test pressure. If test pressure falls outside safe instrument range, attach a note to this effect on the installation instructions. Ensure that the normal working pressure occurs approximately at mid-scale.

2.3.3 Install each gauge complete with DN6 (1/8") or DN8 (1/4") bar stock valve, rated 150°C (300°F) and 6,895 kPa (1,000 psi). Provide pressure snubber on all pump services and coil syphon for steam, air, gas service. Install pressure gauges as noted.

2.3.4 Provide a valved and capped gauge connection at inlet and discharge of all coils and tube bundles in heat exchangers.

2.3.5 Submit a schedule in shop drawing form showing service, location, range, make, and catalogue number for gauges.

3 **EXECUTION**

3.1 PRESSURE GAUGES

3.1.1 Install pressure gauges in the following locations and where shown or specified in the Contract Documents.

3.1.1.1 Suction and discharge of all pumps.

3.1.1.2 High and low sides of all pressure reducing or regulating stations (water, steam, air).

3.1.1.3 Where shown

3.1.2 Provide valved and capped gauge connection at:

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- 3.1.2.1 Entering and leaving side of heat exchangers.
- 3.1.2.2 Entering and leaving side of heating water coils in air supply units.
- 3.1.2.3 Supply and return lines of condenser, chilled, and heating water systems at each branch.
- 3.1.2.4 Where shown.
- 3.2 THERMOMETERS
- 3.2.1 Thermometers to be installed with thermal paste to ensure accurate reading.
- 3.2.2 Install thermometers in the following locations and where shown or specified:
 - 3.2.2.1 Entering and leaving sides of all condenser, chilled, and hot water coils in air supply units.
 - 3.2.2.2 Return lines of main branches of heating, chilled, and condenser water systems.
 - 3.2.2.3 Entering and leaving sides of mixing valves.
 - 3.2.2.4 Supply and return lines at hot water boilers.
 - 3.2.2.5 Supply and return lines on primary heating water loops.
 - 3.2.2.6 Entering and leaving lines of heat exchangers.
 - 3.2.2.7 Where shown in the Contract Documents.

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
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Section Name: **Bases, Hangers and Supports**
Section No.: **20 05 29**
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Section No.: **20 05 29**
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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Provide Shop Drawings for:

1.2.1.1 Hangers and supports

2 **PRODUCTS**

2.1 PIPE ATTACHMENTS

2.1.1 For pipe attachments, review Specification Section 20 07 00 - Mechanical Insulation. Otherwise, adhere to the following:

2.1.1.1 For uninsulated fire servicing piping – ULC and FM approved -, use Taylor Fig. 41 swivel ring hanger.

2.1.1.2 For uninsulated steel pipes, use Taylor Fig. 22Z adjustable clevis up to and including 100mm (4") pipe size, and Taylor Fig. 24 adjustable clevis for sizes 125mm (5") and larger.

2.1.1.3 For uninsulated copper pipes, use Taylor Fig. 52 epoxy coated copper-gard clevis hanger up to and including 100mm (4") pipe size.

2.1.1.4 For uninsulated copper tubing, use Taylor Fig. 43 epoxy coated copper-gard swivel ring hanger up to and including 25mm (1") pipe size.

2.1.1.5 For insulated pipes where the insulation is around the hanger and continuous vapour barrier is not required, use the same hangers as for uninsulated pipes.

2.1.1.6 For insulated pipes where hanger is around insulation, provide galvanized sheet metal insulation shield minimum 250mm (10") long, 1.3mm (18 gauge), between covering and Taylor Fig. 22Z or Fig. 24 clevis, or Taylor Fig. 24L extended clevis, sized to include insulation.

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2.2 UPPER ATTACHMENTS

2.2.1 Provide upper attachments as follows:

2.2.1.1 Standard beam clamp for normal service, Taylor Fig. 425.

2.2.1.2 Top beam clamp Taylor Fig. 407.

2.2.1.3 C clamp with locknut, Taylor Fig. 301.

2.2.1.4 Side beam bracket for light duty side mounting, Taylor Fig. 120.

2.3 PIPE SUPPORT

2.3.1 For vertical adjustment of hanger rods, provide Taylor Fig. 68 forged steel turnbuckle.

2.3.2 Where trapeze hanger is used for a group of pipes, use Taylor Fig. 14 U bolts, except where roller type hanger is indicated on the drawings or in the specifications.

2.3.3 For roller type hangers on both hot and cold pipes, provide Taylor Fig. 70 to 75 protection saddles to suit covering thickness. Use Taylor Fig. 93 adjustable roller hanger for pipe sizes up to and including 150mm (6") over insulation. For pipes 200mm (8") and larger over insulation, use Taylor Fig. 95 adjustable 2-rod roller hanger. On trapeze hangers and where pipe is supported from below, use Taylor Fig. 280S adjustable pipe roller stand.

2.3.4 For vertical pipe support, provide Taylor Fig. 82Z zinc plated steel riser clamp for steel pipe, and Taylor Fig. 85 epoxy coated copper-gard riser clamp for copper pipe.

2.3.5 For guides on vertical pipes, use manufactured pipe alignment guides (e.g. Flexonics). For horizontal pipes, use Taylor Fig. 255 pipe alignment guide. Field fabricated guides with rolled T-section welded to the pipe and guiding shoe, are also acceptable.

3 **EXECUTION**

3.1 GENERAL

3.1.1 Provide supports required for the erection and support of the mechanical work. Construct supports of steel, masonry or concrete, as noted or required. Ensure that steel supports in contact with water or high humidity are galvanized members bolted together using cadmium plated bolts, all others primed steel.

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- 3.1.2 Ensure that housekeeping pads or concrete bases are provided for floor mounted equipment. Make the minimum size, 100mm (4") high for bases or pads, keyed to the floor slab, extending at least 100mm (4") all around the equipment, with 19mm ($\frac{3}{4}$) chamfered edges. Where concrete is provided by Division 03 – Concrete, provide all anchor bolts and setting templates to Division 03 – Concrete.
- 3.1.3 Support suspended equipment from the bottom. Support tanks and other equipment with cast or welded steel saddles having proper curvature and inherent beam strength. Support plenums and sheet metal type air-handling units from auxiliary frames or beams under equipment. Support fans from structural steel frames with steel base plate. Read Division 05 – Metals, for further information.
- 3.1.4 Provide supports and suspended bases having ample strength to safely carry the load under all operating conditions and during testing. Submit support and base details to the Consultant for review. Design supports except springs with a minimum factor of safety of five (5) based on ultimate tensile strength at operating temperature.
- 3.1.5 Ensure that the load onto structures does not exceed the maximum loading as shown on structural drawings or as directed by the Consultant.
- 3.1.6 Take special care in locating hangers and supports to avoid introduction of undue reaction forces onto the structure of the building, to flanges of pumps and equipment, to expansion joints and to the pipe.
- 3.1.7 Install all piping supported from hangers or supports in a manner to ensure that building construction is not weakened or over-stressed, that pipes are secure, vibration free, free to expand and contract and properly graded, and that vertical adjustment of horizontal piping is possible after erection.

3.2 HANGERS

- 3.2.1 For structure attachments, adhere to the following:

- 3.2.1.1 Support hangers directly from the structure only. Do not support pipes or equipment from other pipes, ducts, equipment, suspended ceiling, etc.

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- 3.2.1.2 Suspend hanger rods generally from certified inserts in concrete or by beam clamps. Before welding to steel structure members obtain prior permission of welding method from the Consultant and ensure that loads do not exceed the limit set by the Consultant. Ensure that hanging from floors and roofs made from pre-cast concrete members is from inserts originally cast into the members and provided by this contractor, or by rods passing between the members connected to a steel plate resting on the upper surface.
- 3.2.2 Sliding guides must have sliding surfaces cleaned of all dirt, paint or corrosion and, except for Teflon, have coating of graphite paste added during erection. Adjust guides to allow for free sliding at operating conditions. After assembly, provide these guides with temporary protective cover or wrapping added to keep them free of debris during extent of construction work. When piping is ready to be put into service, remove this protective covering, blow out guides clean of all debris and add paste where applicable. Care must be taken that ample clearance is provided so as not to obstruct free sliding of guide.
- 3.2.3 Install copper, brass, and stainless steel pipes with 3mm ($\frac{1}{8}$ ") thickness of di-electric packing between the pipe and the pipe attachment or use Taylor plastic coated pipe attachments.
- 3.2.4 Install guides on pipes with expansion movement next to expansion joints. Consult expansion joint manufacturer's recommendations and follow their instructions for number and spacing of guides. Use a minimum of two guides on each side of expansion joints.
- 3.2.5 Set hanger rods on steel and copper lines with expansion movement out of plumb in ambient temperature position, a distance equal to one-half pipe movement calculated from anchor point. Base movement on 25mm (1") expansion per 30m (100 ft) of pipe length and 37°C (67°F) temperature difference. Use toggle type insert of beam clamp for such locations.
- 3.2.6 Use roller type hanger only where shown on the drawings.
- 3.2.7 Install all hangers close to points where pipes change direction or where branch piping drops or rises from main.
- 3.2.8 Install vertical riser suitably anchored and guided with manufactured or fabricated guides to maintain accurate vertical position. Protect insulated pipes with 2.2mm (12 gauge) galvanized steel jacket at guides. Guide pipes with expansion

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movement and definite anchor points up to and including 100mm (4") sizes, at every floor or 3m (10 ft). Guide larger pipes and vertical cast iron pipes at every second floor or 7.5m (25 ft).

- 3.2.9 For horizontal cast iron, glass, or polypropylene pipes where packed or friction type mechanical joints are used, provide a support at every joint in straight runs with maximum 1.5m (5 ft) between supports. Where fittings are joined together (elbows, wyes, etc.) provide a separate support for a minimum of every second fitting.
- 3.2.10 For horizontal cast iron, pipes where screwed or bolted type joints are used, the spacing or supports may be increased not to exceed 2.4m (8 ft) between supports, but provide a support for every joint and every second fitting as described above.
- 3.2.11 Use lockwasher with single nut on all bolted connections for pipe supports, anchors, guides and support steel, or use double nuts.
- 3.2.12 During hydrostatic test on all air and vapour piping supported by springs or counterweights, install temporary rigid supports, blocking, etc., or lock the spring against movement to prevent excessive strain on piping or equipment.
- 3.2.13 Use spring hangers where vertical movement of the horizontal pipes may occur due to expansion or contraction. Refer to Sections 20 05 16 – Expansion Compensation and 20 05 48 – Vibration Isolation, for further information.
- 3.2.14 For rod hangers use round steel threaded rod supports on horizontal pipes, spaced at the following maximum intervals and having the minimum diameter as directed.
- 3.2.14.1 For Steel Pipes:

Pipe Diameter mm (in)	Horizontal Spacing of Supports mm (ft)	Single Rod Diameter mm (in)	Double Rod Diameter mm (in)
DN15 (½)	1,524 (5)	9 (¾)	9 (¾)
DN20 (¾)	1,829 (6)	9 (¾)	9 (¾)

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Pipe Diameter mm (in)	Horizontal Spacing of Supports mm (ft)	Single Rod Diameter mm (in)	Double Rod Diameter mm (in)
DN25 (1)	2,134 (7)	9 (³ / ₈)	9 (³ / ₈)
DN32 (1-¼)	2,438 (8)	9 (³ / ₈)	9 (³ / ₈)
DN40 (1-½)	2,743 (9)	9 (³ / ₈)	9 (³ / ₈)
DN50 (2)	3,048 (10)	9 (³ / ₈)	9 (³ / ₈)
DN65 (2-½)	3,048 (10)	13 (½)	9 (³ / ₈)
DN80 (3)	3,658 (12)	13 (½)	9 (³ / ₈)
DN100 (4)	4,268 (14)	16 (⁵ / ₈)	13 (½)
DN125 (5)	4,877 (16)	16 (⁵ / ₈)	13 (½)
DN150 (6)	5,182 (17)	19 (³ / ₄)	16 (⁵ / ₈)
DN200 (8)	5,791 (19)	22 (⁷ / ₈)	19 (³ / ₄)
DN250 (10)	6,706 (22)	22 (⁷ / ₈)	19 (³ / ₄)
DN300 (12)	7,010 (23)	22 (⁷ / ₈)	19 (³ / ₄)
DN375 (15) and over	max. 7,620 (25)	to suit weight	to suit weight

3.2.14.2 For Copper or Stainless Steel Tubing:

Pipe Diameter mm (in)	Horizontal Spacing of Supports mm (ft)	Single Rod Diameter mm (in)	Double Rod Diameter mm (in)
DN15 (½)	1,524 (5)	9 (³ / ₈)	9 (³ / ₈)
DN20 (¾)	1,829 (6)	9 (³ / ₈)	9 (³ / ₈)
DN25 (1)	1,829 (6)	9 (³ / ₈)	9 (³ / ₈)
DN32 (1-¼)	2,134 (7)	9 (³ / ₈)	9 (³ / ₈)
DN40 (1-½)	2,438 (8)	9 (³ / ₈)	9 (³ / ₈)

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Pipe Diameter mm (in)	Horizontal Spacing of Supports mm (ft)	Single Rod Diameter mm (in)	Double Rod Diameter mm (in)
DN50 (2)	2,743 (9)	9 (³ / ₈)	9 (³ / ₈)
DN65 (2-½)	3,048 (10)	13 (½)	9 (³ / ₈)
DN80 (3)	3,048 (10)	13 (½)	9 (³ / ₈)
DN100 (4)	3,658 (12)	16 (⁵ / ₈)	13 (½)

- 3.2.15 Do not use pipe hooks, chains, or perforated straps.
- 3.2.16 Use angle or channel iron welded frames for trapeze hangers.
- 3.2.17 For all drain pipe installed under structural slab on disturbed soil (up fill), suspend piping via galvanized clevis hangers embedded in structural slab. Hanger spacing shall be per pipe manufacturer recommendations, with minimum of two (2) hangers per pipe length.

3.3 ANCHORS

- 3.3.1 Design pipe anchors to restrain the movement of pipes in all directions.
- 3.3.2 Take special care in locating anchors to avoid introduction of undue reaction forces into the structure of the building, to flanges of pumps and equipment, to expansion joints and to the pipe.
- 3.3.3 Fabricate anchors and guides of structural steel channels, angles or plates secured to building structure. Size cylindrical type guides for full pipe insulation.
- 3.3.4 Submit for review by the Consultant prior to installation, a detailed design prepared in conjunction with the expansion joint manufacturer for anchors, guides, and their proposed connection to the structure, including reaction forces and loads imposed on structure. All Drawings must be signed by a Professional Engineer registered in the Province of Ontario. Do not proceed with installation until after receipt of reviewed drawings.

3.4 DUCT SUPPORT

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- 3.4.1 Provide all foundations and supports required for the proper erection of the ductwork. Use concrete, masonry, and steel as specified, shown or required. Provide lightweight concrete fill around buried ductwork.
- 3.4.2 Co-operate with Division 03 – Concrete and Division 05 – Metals, and co-ordinate the work under this Division with those Divisions to ensure that opening required in floors, walls and partitions for the ducts are provided in the exact location required.
- 3.4.3 Where possible, use beam clamps, pre-set sleeves, and inserts for attachment to or passage through work under other Divisions. Do not weld to or cut into the work of other Specification Sections unless with the special permission of the Consultant.
- 3.4.4 Where vibration mountings are required, make necessary provisions in accordance with the recommendations of the equipment manufacturer. Refer to Sections 20 05 16 – Expansion Compensation and 20 05 48 – Vibration Isolation, for further information.
- 3.4.5 Install ducts securely supported from hangers or supports, in a manner to ensure that building construction is not weakened or over-stressed, that ducts are secure, free of vibration, free to expand and contract and properly graded.
- 3.4.6 Bolt steel frames to galvanized steel ducts. Rivet aluminum frames to aluminum ducts. Bolt steel frames to soldered lugs on copper ducts. Use di-electric gaskets. Bolt steel frames to welded lugs on stainless steel ducts.
- 3.4.7 Extend angles 50mm (2") to either side of ducts. For non-ferrous ducts, use di-electric gasket between duct and support. For additional stainless steel ducts use supports not directly attached to the duct. For watertight ducts, use supports not attached to the duct.
- 3.4.8 Support vertical ducts as follows:
 - 3.4.8.1 Support vertical ducts in duct shafts at the top and the bottom of the shafts and at every floor in between. Supply auxiliary steel structural steel, sized as required.
 - 3.4.8.2 Support other vertical ducts at the passage through every floor.
- 3.4.9 Support round and oval ducts using a 38mm by 3mm (1-1/2" x 1/8")

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split ring bolted at each end, extending minimum 75mm (3") on each side.

3.4.10 Support rectangular ducts using a bolted or tack welded frame on 38mm by 38mm by 3mm (1-½" x 1-½" x 1/8") angle steel.

3.4.11 In T-bar ceilings, attach diffusers connected to flexible duct directly to the ceiling suspension system main runners. Use this method for diffusers or mechanical items weighing less than 9 kg (20 lbs.). Support diffusers or equipment weighing more than 9 kg (20 lbs.) directly from the roof or floor.

3.5 EQUIPMENT SUPPORT

3.5.1 Place all suspended equipment on welded steel bases of up to 150mm (6") profile steel, stiffened with 3mm (1/8") checkered steel plate. Co-ordinate with Division 05 – Metals.

3.5.2 Place floor plates on 100mm (4") concrete housekeeping pads. Ensure that the load on the structure does not exceed 488 kg per square meter (100 lbs. per square feet) projected floor area within the perimeter of the supports.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All necessary vibration isolation elements for piping and equipment, and vibration isolation bases for equipment to prevent noise levels from exceeding the room criteria listed in Table 1, Chapter 48 of the ASHRAE 2011 HVAC Applications Handbook.

1.2.2 Manufacturer of vibration isolation equipment shall have the following responsibilities:

1.2.2.1 Determine vibration isolation sizes and locations.

1.2.2.2 Provide piping and equipment isolation systems as scheduled or specified in the Contract Documents.

1.2.2.3 Guarantee specified isolation system deflection.

1.2.2.4 Provide installation instructions, drawings, and field supervision to assure proper installation and performance.

1.2.3 In addition to the work of this Section, comply with description of individual systems and general requirements of all other Specification Sections of this Division.

1.3 SUBMITTALS

1.3.1 The Contractor shall supply to the manufacturer approved drawings of all equipment to be isolated.

1.3.2 The manufacturer shall supply shop drawings of all vibration control components to be used on the project.

1.3.3 As a minimum provide the following information:

1.3.3.1 Catalogue cuts and data sheets on specific vibration isolators to be utilized showing compliance with the specifications.

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- 1.3.3.2 An itemized list showing the items of equipment or piping to be isolated, the isolator type of model number selected, isolator loading and deflection, and reference to specific drawings showing base and construction where applicable.
- 1.3.3.3 Grooved joint couplings and fittings shall be shown on drawings and product submittals, and shall be specifically identified with the applicable style or series designation.
- 1.3.3.4 Written approval of the base design to be used, obtained from the equipment manufacturer.
- 1.3.3.5 Drawings showing equipment base constructions for each machine, including dimensions, structural member sizes and support point locations.
- 1.3.3.6 Drawings showing methods for isolation of pipes and ductwork piercing walls and slabs.
- 1.3.4 Submit letter from manufacturer certifying that vibration isolation equipment have been installed in accordance with their recommendations and the Contract Documents, and that it operates to their satisfaction.

1.4 QUALITY ASSURANCE

- 1.4.1 It is the objective of this Specification Section to provide the necessary design for the control of excessive noise and vibration in the Building due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork, or conduit. The installation of all vibration isolation units, and associated hangers and bases, shall be under the direct supervision of the vibration isolation manufacturer's representative.
- 1.4.2 All vibration isolators shall have either known undeflected heights or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
- 1.4.3 All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range of not less than 50% above the design deflection.

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1.4.4 The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than "10%.

1.4.5 All neoprene mountings shall have a Shore hardness of 30 to 60 "5, after minimum aging of 20 days or corresponding oven-aging.

1.4.6 All grooved joint couplings and specialties shall be the products of a single manufacturer.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All vibration isolation devices shall be the product of a single manufacturer.

2.2 TYPE A SPRING ISOLATORS

2.2.1 Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 6mm (1/4") neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

2.2.2 Corrosion resistance where exposed to corrosive/outdoor environment shall be with:

2.2.2.1 Springs neoprene coated.

2.2.2.2 Hardware cadmium plated.

2.2.2.3 All other metal parts hot-dip galvanized.

2.2.3 Designed and installed so that ends of springs remain parallel.

2.2.4 Non-resonant with equipment forcing frequencies or support structure natural frequencies.

2.2.5 Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.

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2.2.6 Type A spring isolators to be Mason Type SLF.

2.3 TYPE B SPRING ISOLATORS

2.3.1 Isolators shall be same as Type A, except:

2.3.1.1 Provide built-in resilient vertical limit stops.

2.3.1.2 All restraining bolts shall have large rubber grommets to provide cushioning in the vertical as well as horizontal modes. The hole through the bushing shall be a minimum of 20mm (0.75") larger in diameter than the restraining bolt. Horizontal clearance on the sides between the spring assembly and the housing shall be a minimum of 12mm (0.5") to avoid bumping and interfering with the spring action. Vertical limit stops shall be out of contact during normal operation.

2.3.1.3 Provide tapped holes in top plate for bolting to equipment.

2.3.1.4 Isolators shall be capable of supporting equipment at a fixed elevation during equipment erection.

2.3.2 Housings and springs shall be powder coated and hardware electro-galvanized.

2.3.3 Type B spring isolators to be Mason Type SLR.

2.4 TYPE C SPRING HANGER ROD ISOLATORS

2.4.1 Hangers shall be manufactured with minimum characteristics as Type A isolators, but without the neoprene element:

2.4.1.1 Springs are seated in a steel washer reinforced neoprene cup that has a neoprene bushing projecting through the bottom hole to prevent rod to hanger contact.

2.4.1.2 Spring diameters and the lower hole sizes shall be large enough to allow the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing.

2.4.1.3 If ducts are suspended by flat strap iron, the hanger assembly shall be modified by the manufacturer with an eye on top of the box and on the bottom of the spring hanger rod to allow for bolting to the hanger straps.

2.4.2 Submittals on either of the above hangers shall include a scaled drawing of the hanger showing the 30° capability.

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2.4.3 Where operating weight differs from installed weight provide built-in adjustable limit stops to prevent equipment rising when weight is removed. Stops shall not be in contact during normal operation.

2.4.4 Type C spring hanger rod isolators to be Mason Type 30 or for straps W30.

2.5 TYPE D ELASTOMETER MOUNTING TYPES

2.5.1 Neoprene mountings shall have a minimum static deflection of 9mm (0.35"). All metal surfaces shall be oil-resistant neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole and cap screw on top. Steel rails shall be used above the mountings under equipment such as small vent sets to compensate for the overhang.

2.5.2 Neoprene to be compounded to hardness no greater than 70 durometer.

2.5.3 Mounts to have straight line deflection curve.

2.5.4 Type D elastomer isolators to be Mason Type ND.

2.6 TYPE E ELASTOMETER HANGER ROD ISOLATORS

2.6.1 Isolators shall incorporate a moulded unit type neoprene element and steel retainer box encasing the neoprene mounting.

2.6.2 Neoprene to be compounded to hardness no greater than 70 durometer.

2.6.3 Isolator to have sufficient clearance between mounting hanger rod and steel retainer box.

2.6.4 Type E hanger rod isolators to be Mason Type HD.

2.7 TYPE F PAD TYPE ELASTOMETER MOUNTINGS

2.7.1 Elastomer pads to incorporate the following:

2.7.1.1 20mm ($\frac{3}{4}$ ") minimum thickness per layer of pad.

2.7.1.2 Suitable top bearing plate provided to uniformly distribute load.

2.7.1.3 Ribbed or waffled design.

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- 2.7.1.4 15% deflection.
- 2.7.1.5 Standard neoprene with moderate oil-resistance, compounded to hardness no greater than 70 durometer.
- 2.7.1.6 1.6mm (16 ga.) galvanized steel plate between multiple layers of pad thickness.
- 2.7.1.7 Bolts through equipment and pad shall be oversized and provided with resilient washers and bushings.
- 2.7.2 Type F pad to be Mason Type Super W.
- 2.8 TYPE G PAD TYPE ELASTOMETER MOUNTINGS
 - 2.8.1 Elastomer pads to incorporate the following:
 - 2.8.1.1 High quality bridge bearing neoprene.
 - 2.8.1.2 3mm ($\frac{1}{8}$ ") deflection.
 - 2.8.1.3 Maximum loading 6,895 kPa (1000 psi).
 - 2.8.1.4 Suitable bearing plate to distribute load.
 - 2.8.1.5 Minimum thickness 25mm (1").
 - 2.8.2 Type G pad to be Mason Type BBNR.
- 2.9 TYPE H COMBINATION SPRING/ELASTOMETER HANGER ROD ISOLATORS
 - 2.9.1 Hangers shall consist of rigid steel frames containing minimum 32mm (1-1/4") thick neoprene elements at the top and a steel spring with general characteristics as described in Type C, seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring.
 - 2.9.2 Neoprene to be compounded to hardness no greater than 70 durometer.

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2.9.3 Submittals shall include a hanger drawing showing the 30° capability.

2.9.4 Type H isolator to be Mason Type 30N.

2.10 INTEGRAL STRUCTURAL STEEL BASE, TYPE B-1

2.10.1 Base to be reinforced as required to prevent base flexure at start-up and misalignment of drive and driven units. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped. Pump bases for split case pumps shall be large enough to support suction and discharge elbows. Centrifugal fan bases to be complete with motor slide rails, drilled for drive and driven unit mounting template.

2.10.2 All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 350mm (14") provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 25mm (1").

2.10.3 Type B-1 base to be Mason Type WF.

2.11 CONCRETE INERTIA BASE, TYPE B-2

2.11.1 Concrete inertia bases shall be formed in a structural steel perimeter base, reinforced as required to prevent flexure, misalignment of drive and driven unit or stress transfer into equipment.

2.11.2 The base shall be complete with motor slide rails, pump base elbow supports, and complete with equipment bolting provisions and isolators. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 150mm (6"). The base depth need not exceed 300mm (12") unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 12mm (1/2") bars welded in place on 150mm (6") centers running both ways in a layer 40mm (1-1/2") above the bottom. Forms shall be furnished with steel templates to hold the anchor bolt sleeves and anchor bolts while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 25mm (1") minimum clearance between base and housekeeping pad. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable.

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2.11.3 Minimum thickness of the inertia base shall be according to the following tabulation:

<u>Motor Size</u> kW (hp)	<u>Min. Thickness</u> mm (inches)
up to 11 (15)	150 (6)
15-37 (20-50)	200 (8)
45-55 (60-75)	250 (10)
75-185 (100-250)	300 (12)
225-375 (300-500)	400 (16)

2.11.4 Type B-2 inertia base to be Mason Type BMK or K.

2.12 SPRING ISOLATED ROOF CURB, TYPE B-3

2.12.1 Structural roof curb assembly to have a top and bottom frame resiliently connected by spring isolator complying with specification Type A.

2.12.2 The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind forces. All directional neoprene snubber bushings shall be a minimum of 6mm (1/4") thick. Steel springs shall be laterally stable and rest on 6mm (1/4") thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curb's waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curb's waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 50mm (2") of insulation.

2.12.3 Type B-3 curb to be Mason Type RSC.

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2.13 MOUNTING TYPES AND STATIC DEFLECTION SCHEDULE

Equipment				Slab on Grade			Suspended Slabs		
Type	Category	HP or Other	RPM	Base Type	Isolator Type	Min. Defl. mm (in.)	Base Type	Isolator Type	Min. Defl. mm (in.)
Refrigeration Machines and Chillers	Reciprocating	All	All	(1)	D	6 (1/4")	(1)	B	38 (1-1/2")
	Centrifugal scroll	All	All	(1)	F	6 (1/4")	(1)	B	38 (1-1/2")
	Screw	All	All	(1)	F	25 (1")	(1)	B	64 (2-1/2")
	Absorption	All	All	(1)	F	6 (1/4")	(1)	B	38 (1-1/2")
	Air-cooled recip, scroll	All	All	(1)	D	6 (1/4")	(1)	B	38 (1-1/2")
	Air-cooled screw	All	All	(1)	B	25 (1")	B-1	B	64 (2-1/2")
Air Compressors and Vacuum Pumps	Tank-mtd horiz.	≤10	All	(1)	A	19 (3/4")	(1)	A	38 (1-1/2")
		≥15	All	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
	Tank-mtd vert.	All	All	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
		All	All	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
		All	All	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
Pumps	Close coupled	≤7.5	All	B-1	D	6 (1/4")	B-2	A	19 (3/4")
		≥10	All	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
	Inline	5 to 25	All	(1)	A	19 (3/4")	(1)	A	38 (1-1/2")
		≥30	All	(1)	A	38 (1-1/2")	(1)	A	38 (1-1/2")
	End suction, double suction split case	≤40	All	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
		50 to 125	All	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
		≥150	All	B-2	A	19 (3/4")	B-2	A	64 (2-1/2")
	Packaged pump	All	All	(1)	A	19 (3/4")	B-2	A	38 (1-1/2")
Cooling towers	All	All	≤300	(1)	G	6 (1/4")	(1)	B	89 (3-1/2")
			301to500	(1)	G	6 (1/4")	(1)	B	64 (2-1/2")
			≥501	(1)	G	6 (1/4")	(1)	B	19 (3/4")
Boilers	Fire-tube	All	All	(1)	F	6 (1/4")	B-1	B	38 (1-1/2")
	Water-tube	All	All	(1)	F	3 (1/8")	(1)	F	3 (1/8")
	Steam	All	All	(1)	F	6 (1/4")	B-1	B	38 (1-1/2")
Fans: axial, plenum, cabinet, inline	≤ 22 in dia.	All	All	(1)	D	6 (1/4")	B-2	A	19 (3/4")
	≥ 24 in dia.	≤2 in SP	≤300	B-1	A	64 (2-1/2")	B-2	A	89 (3-1/2")
			301to500	B-1	A	19 (3/4")	B-2	A	64 (2-1/2")
			≥501	B-1	A	19 (3/4")	B-1	A	38 (1-1/2")
		>2 in SP	≤300	B-2	A	64 (2-1/2")	B-2	A	89 (3-1/2")
			301to500	B-2	A	38 (1-1/2")	B-2	A	64 (2-1/2")
			≥501	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
		≥50	≤300	B-1	D	6 (1/4")	B-1	A	19 (3/4")
			≤300	B-1	A	64 (2-1/2")	B-1	A	89 (3-1/2")
Centrifugal fans	≥ 24 in dia.	All	≤300	B-1	A	64 (2-1/2")	B-1	A	89 (3-1/2")
			301to500	B-1	A	38 (1-1/2")	B-1	A	64 (2-1/2")
			≥501	B-1	A	19 (3/4")	B-1	A	19 (3/4")
			≤300	B-2	A	64 (2-1/2")	B-2	A	89 (3-1/2")
			≤300	B-2	A	64 (2-1/2")	B-2	A	89 (3-1/2")

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Equipment				Slab on Grade			Suspended Slabs		
Type	Category	HP or Other	RPM	Base Type	Isolator Type	Min. Defl. mm (in.)	Base Type	Isolator Type	Min. Defl. mm (in.)
			301to500 ≥501	B-2 B-2	A A	38 (1-½") 25 (1")	B-2 B-2	A A	64 (2-½") 38 (1-½")
Propeller fans	Wall-mounted Roof-exhauster	All All	All All	(1) (1)	F F	6 (¼") 6 (¼")	(1) B-3	F B	6 (¼") 38 (1-½")
Heat pumps, fan coils, CRAC units	All	All	All	(1)	A	19 (¾")	(1)	A	19 (¾")
Condensing units	All	All	All	(1)	F	6 (¼")	(1)	B	38 (1-½")
AHUs, AC, heating and ventilation units	All All	≤10 ≤15, ≤4 in SP >15, >4 in SP	All ≤300 301to500 ≥501 ≤300 301to500 ≥501	(1) (1) (1) (1) B-1 B-1 B-1	A A A A A A A	19 (¾") 19 (¾") 19 (¾") 19 (¾") 19 (¾") 19 (¾") 19 (¾")	(1) B-2 (1) (1) B-2 B-2 B-2	A A A A A A A	19 (¾") 89 (3-½") 64 (2-½") 38 (1-½") 89 (3-½") 64 (2-½") 38 (1-½")
Packaged RTUs	All	All	All	(1)	G	6 (¼")	B-3	A	19 (¾")
Ducted rotating equipment	Small fans, fan powered boxes	≤600 cfm >600 cfm		(1) (1)	A A	13 (½") 19 (¾")	(1) (1)	A A	13 (½") 19 (¾")
Generators	All	All	All	(1)	A	19 (¾")	B-2	A	64 (2-½")
Heat exchangers, tanks	Plate and frame			(2)	F	3 (⅛")	(2)	F	3 (⅛")
Piping (see specs)	Floor supported Suspended			- -	B H	25 (1") 32 (1-¼")	- -	B H	25 (1") 32 (1-¼")
Transformer, dry type	Floor mounted Suspended Wall mounted			(2)	D	6 (¼")	(2) (2) (2)	D E D	6 (¼") 6 (¼") 6 (¼")

2.13.1

Notes:

- (1) No base, isolator directly attached to equipment.
- (2) Base as recommended and/or provided by manufacturer.

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3 EXECUTION

3.1 GENERAL

- 3.1.1 Have all materials and systems for vibration isolation designed and supplied by one company, referred to in this Section as the 'manufacturer'.
- 3.1.2 Install all products in accordance with manufacturer's written instructions. Vibration isolators must not cause any change or position of equipment or piping resulting in piping stresses or misalignment.
- 3.1.3 Provide through the manufacturer all vibration isolation equipment work and measures to prevent the transmission of objectionable vibration to the building structure and from one area to another area. Provide all necessary drawings indicating isolator locations and base dimensions. Have the installation directed and supervised by the manufacturer. Supply to the manufacturer the necessary copies of all drawings of equipment to be isolated.
- 3.1.4 Consider the areas classified as follows for selection of vibration control devices:
 - 3.1.4.1 Mechanical rooms or equipment locations in basement or sub-basement areas only and not bordering areas regularly occupied are 'non-critical'.
 - 3.1.4.2 Mechanical rooms or equipment locations bordering habitable suites, boardrooms, conference rooms, private offices are 'ultra-critical'. This shall include all mechanical penthouses and all mechanical compartment rooms.
- 3.1.5 Vibration isolation is not required for the following equipment between equipment and building only, but provide isolated connection to these for pipes and ducts:
 - 3.1.5.1 Fire pumps
 - 3.1.5.2 Sump pumps, sewage pumps
- 3.1.6 All piping and ductwork to be isolated shall freely pass through walls and floors without rigid connections. Penetration points shall be sleeved using acoustical sleeves, or otherwise formed to allow passage of piping or ductwork, and maintain 20mm ($\frac{3}{4}$ ") to 32mm ($1\frac{1}{4}$ ") clearance around the outside surfaces. This clearance

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space shall be tightly packed with fiberglass, and caulked airtight after installation of piping or ductwork.

- 3.1.7 No rigid connections between equipment and building structure shall be made that degrades the noise and vibration isolation system specified in this Section.
- 3.1.8 Electrical conduit connections to isolated equipment shall be flexible to allow free motion of isolated equipment.
- 3.1.9 Do not install any equipment, piping, or conduit, which makes rigid contact with the building unless permitted in this Specification. Building includes, but is not limited to, slabs, beams, columns, studs, and walls.
- 3.1.10 Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.
- 3.1.11 Bring to the Consultant's attention prior to installation any conflicts with other trades, which will result in unavoidable rigid contact with equipment or piping as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
- 3.1.12 Obtain inspection and approval of any installation to be covered or enclosed, prior to such closure.
- 3.1.13 Diagonal restraints shall be attached at the centerline of thrust.
- 3.1.14 Vertical piping loads, including water strainers, valves between pump base elbow supports and the suction and discharge header piping, shall be supported by the pump base spring isolators without stress or strain to the pump housing.
- 3.1.15 Correct, at no additional cost, all installations, which are deemed defective in workmanship or materials.
- 3.2 **EQUIPMENT ISOLATORS**
- 3.2.1 Mount floor mounted equipment on 100mm (4") concrete housekeeping pads over complete floor area of equipment. Mount vibration isolating devices and related inertia blocks on concrete pad.

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- 3.2.2 Each fan and motor assembly shall be supported on a single structural steel frame. Provide all ductwork connected to vibration-isolated equipment at both inlet and outlet with flexible connectors having sufficient length and flexibility to eliminate vibration transmission and to not short circuit the effectiveness of the vibration isolation. Make flexible connections of glass fibreglass cloth sleeves, sealed to prevent air leakage. Install a minimum length of flexible connection on both sides equal to static pressure of the fan in inches but not less than 150mm (6").
- 3.2.3 The machine to be isolated shall be supported by a structural steel frame or concrete inertia base.
- 3.2.4 Brackets shall be provided to accommodate the isolator. The vertical position and size of the bracket shall be specified by the isolation manufacturer.
- 3.2.5 The minimum operating clearance between the equipment frame or rigid steel base frame and the housekeeping pad or floor shall be 25mm (1"). Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 50mm (2").
- 3.2.6 The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.
- 3.2.7 The isolators shall be installed without raising the machine and frame assembly.
- 3.2.8 After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.
- 3.2.9 Air handling equipment and centrifugal fans shall be protected using horizontal thrust restraints against excessive displacement weight which results from high air thrust when thrust forces exceed 10% of the equipment.
- 3.2.10 Rooftop equipment isolators must be bolted to the equipment and structure. Mountings must be designed to resist 160 km/h (100mph) wind loads.
- 3.2.11 Isolation mounting deflection shall be the minimum as specified or

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scheduled on the Drawings.

3.2.12 Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 6mm (1/4").

3.2.13 Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base or isolators.

3.3 PIPING ISOLATORS

3.3.1 All piping isolators are included under this Section.

3.3.2 Where piping connects to mechanical equipment install expansion joints, or stainless hoses if expansion joints are not suitable for the service. All piping passing through the equipment walls, floors or ceilings shall be protected against sound leakage by means of an acoustical seal.

3.3.3 Isolate piping outside the shafts as follows:

3.3.3.1 All water piping in machine rooms, including strainers, filters, valves and associated equipment with water systems.

3.3.3.2 Piping and associated equipment where exposed on roof.

3.3.3.3 Water piping within 12.2m (40 ft) or 100 x pipe diameters, whichever is greater, from connected rotating equipment, using Type H hangers with the same static deflection as specified for the equipment. If piping is connected to equipment located beneath occupied spaces and hangs from ceilings under occupied spaces, the first four hangers shall have a minimum deflection of 20mm (3/4") for pipe sizes up to and including 75mm (3"), 40mm (1-1/2") deflection for pipe sizes over 75mm (3") and up to and including 150mm (6"), and 65mm (2-1/2") deflection thereafter.

3.3.4 The isolators shall be installed with the isolator hanger box attached to, or hung as close as possible to, the main structural elements of the building.

3.3.5 The isolators shall be suspended from substantial structural members, not from slab diaphragm unless specifically permitted.

3.3.6 Hanger rods shall be aligned to clear the hanger box.

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3.3.7 Horizontal suspended pipe 50mm (2") and smaller and all steam piping shall be suspended by Type E isolator with a minimum 6mm ($\frac{1}{4}$ ") deflection. Water pipe larger than 50mm (2") shall be supported by Type H isolator with a minimum 32mm (1- $\frac{1}{2}$ ") static deflection.

3.3.8 Horizontal pipe floor supported at slab shall be supported via Type A or B, with a minimum static deflection of 25mm (1") or same deflection as isolated equipment to which pipe connects whichever is the greater.

3.3.9 All vertical risers shall be supported by spring isolators designed to support the riser filled with water, if it is a water line. Assigned loads must be within the building design limits at the support points. Neutral central resilient anchors shall direct movement up and down. The anchors shall be capable of holding an upward force equal to the water weight when the system is drained. If one level cannot accommodate this force, anchors can be located on two or three adjacent floors. Resilient guides shall be spaced and sized properly depending on the pipe diameter. The initial spring deflection shall be a minimum of 20mm ($\frac{3}{4}$ ") or four times the thermal movement at the isolator location, whichever is greater. Proper provision shall be made for seismic protection in seismic zones. Support spring mountings shall be Type A, anchors and telescoping guides as described under the Products section.

3.3.10 Pipe sway braces, where required, shall utilize two (2) neoprene elements (type D to accommodate tension and compression forces).

3.3.11 Pipe extension and alignment connectors: Provide connector at riser takeoffs, cooling and heating coils, and elsewhere as required to accommodate thermal expansion and misalignment.

3.4 DUCT ISOLATORS

3.4.1 All air ducts with a cross section of 0.19m² (2ft²) or larger shall be isolated from the building structure by Type C hangers or Type A floor supports with a minimum deflection of 20mm ($\frac{3}{4}$ "). Isolators shall continue for minimum 15m (50 ft) from the equipment. If air velocity exceeds 5.3 mps (1000 fpm), hangers or supports shall continue for an additional 15m (50 ft) or as shown on the Drawings

3.5 ISOLATOR POSITION

3.5.1 Close to building structure.

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- 3.5.2 Between building structure and supplementary steel if required.
- 3.5.3 Suspend isolators from rigid and massive support points.
- 3.5.4 Supplementary steel to be sized for a maximum deflection of 1.6mm ($\frac{1}{16}$ ") at center span.
- 3.5.5 Support piping in shafts and floor supports entering shaft with Type B isolators or Type H hangers depending on piping loads and support point space conditions within shafts.
- 3.5.6 Guide piping in shafts as required with approved mounting designs incorporating Mason Type ADA mountings to building. Prevent direct contact of piping with building structure.
- 3.6 MANUFACTURER'S REVIEW
- 3.6.1 On completion of installation of all vibration isolation and expansion compensation devices specified in this Section, the manufacturer shall inspect the completed system; check the vibration levels in the areas as requested by the Consultant, and report in writing any installation error, improperly selected isolation devices, or other faults in the system that could affect the performance of the system. A written report shall be submitted outlining corrective work necessary to comply with the above specifications. Corrective work shall be the responsibility of the installing Subcontractor.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

2 **PRODUCTS**

Not Used

3 **EXECUTION**

3.1 PIPE SYSTEMS

3.1.1 After finished painting is complete, identify each pipe with SMS Coil-Mark or adhesive style building service pipe markers.

3.1.2 Use capital letters minimum 51mm (2") high for DN80 (3") diameter piping or larger, including insulation, and 19mm ($\frac{3}{4}$ ") size capital letters on smaller diameters.

3.1.3 Use flow arrows to indicate direction of flow. Use double arrow where flow is reversible. Arrow shall be solid black or white; minimum 152mm (6") long by 51mm (2") wide for DN80 (3") diameter piping or larger, including insulation, and 102mm (4") long by 19mm ($\frac{3}{4}$ ") wide on smaller diameters.

3.1.4 Locate identification and flow arrows as follows:

3.1.4.1 Behind each access door.

3.1.4.2 At each change of direction and take-off.

3.1.4.3 Not more than 12.2m (40 ft) apart on all pipes exposed and/or located behind accessible ceiling.

3.1.4.4 On both sides of sleeves.

3.1.4.5 Adjacent to valves.

3.1.4.6 Above each floor or platform for vertical exposed pipes approximately 1,524mm (5 ft.) above floor.

3.1.5 SMS Coil-Mark or adhesive style building service pipe markers shall be mounted in a visible neat, durable manner. Upon completion of project, provide one complete set of markers used

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for the Owner.

- 3.1.6 Use wording shown on the Legend on the Drawings or as instructed by the Consultant. Special system designations and abbreviations shall be submitted to Consultant for approval prior to use.
- 3.1.7 Colour coding to be as per the following schedule. For all other services, provide colour coding in conformance with CAN/CGSB-24.3 and ANSI A131.

MARKER LEGEND	CLASSIFICATION	
	COLOUR	
Description and Service	Primary	Secondary
City Water	Green	
Cold Water	Green	
Cooling Tower Water	Green	
Chilled Water	Green	
Ice Water	Green	
Domestic Hot Water	Green	
Domestic Hot Water Recirculation	Green	
Low Temp. Heating Water (Up To 121°C / 250°F)	Yellow	Black
High Temp. Heating Water (Over 121°C / 250°F)	Yellow	Black
Make-Up Water	Yellow	Black
Boiler Feed Water	Yellow	Black
Condensate	Yellow	Black
Blow-Off Water	Yellow	Black
Treated Water	Green	
Brine	Green	
Waste Water	Green	

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MARKER LEGEND

CLASSIFICATION COLOUR

Description and Service	Primary	Secondary
Storm Water	Green	
Acid Drain	Yellow	Black
Fire Protection Water	Red	White
Sprinkler Water	Red	White
Carbon Dioxide (Fire Protection)	Red	White
Plumbing Vent	Green	
Heating Vent	Yellow	Black
Low Pressure Steam (103 kPa / 15 psi Or Less)	Yellow	Black
High Pressure Steam (Above 103 kPa / 15 psi)	Yellow	Black
Hydraulic Oil	Yellow	Black
Instrument Air	Green	
Diesel Exhaust	Yellow	Black
Fuel Oil	Yellow	Orange
LP Gas	Yellow	Orange
Natural Gas	Yellow	Orange
Chlorine	Yellow	Black
Nitrogen	Blue	Yellow
Vacuum	Green	
Compressed Air (690 kPa / 100 psi Or Less)	Green	
Compressed Air (Above 690 kPa / 100 psi)	Yellow	Black

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3.1.8 Use primary colours for full length of piping or in minimum 914mm (36") long sections; use minimum 457mm (18") long sections on each side of valves. Use secondary colours in min. 51mm (2") wide bands.

3.1.9 Install pipe identification in accordance with the manufacturer's recommendations.

3.2 VALVES

3.2.1 Supply and attach to each valve (except fixture stops) a lamacoid tag 32mm (1-¼") in diameter or 38mm (1-½") square, similar to SMS RP/SP-1500 series. The system code to be 5mm (³/₁₆") high characters on the top line, valve numbers to be 9mm (³/₈") high on the bottom line. Tags to be colour coded in conformance with piping system colours as per CAN/CGSB-24.3.

3.2.2 Attach tag to valve with a brass chain.

3.2.3 Schedule the valve numbers using a sequential numbering system. For fire protection valves, co-ordinate valve numbers with the annunciator panel numbering system.

3.2.4 Prepare and submit valve directories and charts giving number, size, location, purpose, and normal position (opened or closed) for each valve.

3.2.5 Provide two (2) framed copies of the valve charts and locate where directed by the Consultant.

3.2.6 All control, drain, and test connection valves shall be provided with signs indicating their purpose.

3.3 EQUIPMENT

3.3.1 Identify all fans, pumps, controls, starters, switches, pushbuttons, and all other equipment as to service by a white lamacoid engraved nameplate on black background. Submit sample plates and lettering to the Consultant. Attach plates only after all painting work is completed. Use mechanical fastening devices acceptable to the Consultant.

3.3.2 Manufacturer's nameplates shall be affixed to all equipment, serial number and all information usually provided, including voltage, cycle, phase, motor power, etc., name of the manufacturer and their address. All stamped etched or engraved lettering on plates

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shall be perfectly legible. Do not paint over nameplates and, where apparatus is to be concealed, attach the nameplates in an approved location on the equipment support or frame.

- 3.3.3 Identify all equipment with the corresponding remote controls.
- 3.3.4 Equipment plates shall have 9mm ($\frac{3}{8}$ ") capital letters; starter plates shall have 3mm ($\frac{1}{8}$ ") capital letters. All plates shall be sized to accommodate required description. Locate plates conspicuously and secure with self-tapping sheet metal screws where possible, or with double sided adhesive tape. Recognizable abbreviations will be acceptable, other proposed abbreviations to be approved by Consultant.
- 3.4 DUCTWORK
- 3.4.1 Identify all ductwork with duct markers using black or white text to contrast surface being identified.
- 3.4.2 Identification location shall conform to guidelines for duct systems, and shall indicate flow medium, function, and direction.
- 3.4.3 SMS Coil-Mark or adhesive style building service duct markers, or equal, shall be mounted in a visible neat, durable manner. Upon completion of project, provide one complete set of markers used for the Owner.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 GENERAL REQUIREMENTS

1.2.1 Test, balance and adjust all systems to the Drawings and Specifications, in accordance with the intent and requirements of the ASHRAE Guide - Testing, Adjusting and Balancing (TAB) (Chapter 38, 2011 ASHRAE Application Handbook).

1.3 QUALIFICATION

1.3.1 The Testing, Balancing and Adjusting (TAB) Contractor must be a member in good standing with the National Environmental Balancing Bureau (NEBB), the Canadian Associated Air Balance Council (CAABC) or the National Building Comfort Testing Association (NBCTA).

1.4 SCOPE OF WORK

1.4.1 The TAB Contractor shall:

1.4.1.1 Within fourteen (14) days after award of contract, submit proof of certification for CAABC / NBCTA / NEBB.

1.4.1.2 Within thirty (30) days after award of contract, submit a report to the consultant summarizing the TAB Contractor's comments and recommendations regarding their review of the contract documents. Meet with the Contractor, Owner and Consultant as necessary to discuss.

1.4.1.3 Within thirty (30) days after Contract award, submit an outline of proposed TAB procedures, or alternatively, provide a copy of the latest edition of CAABC / NBCTA / NEBB Procedural Standards.

1.4.1.4 Conduct ongoing reviews of all related construction documentation, including co-ordination Drawings and shop drawings.

1.4.1.5 Visit the Site a minimum of once per month during construction, commencing when the pipe and/or duct installation starts. Submit a written report to the Consultant, including date of visit, areas

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observed, and any anticipated problems, which could adversely affect the TAB work.

- 1.4.1.6 Prior to commencing the TAB work, the TAB Subcontractor shall submit the list of instruments they will use on the project, together with a record of calibration dates and procedures.
- 1.4.1.7 Perform all pre-balancing work as specified in respective procedures.
- 1.4.1.8 Furnish all TAB labour, instruments and services necessary to complete the TAB work for air systems and water systems to achieve the required air and water flow rates. For fans with fixed drives, provide preliminary balance for first set of sheaves, advise the Division 23 - HVAC Subcontractor of results, install new sheaves, and rebalance system following installation of second set of sheaves. Adjust adjustable drives for required rpm and airflow. Adjust VAV box minimum and maximum airflows. Adjust and set all volume control devices to achieve proper air distribution, pressures and patterns in all parts of supply return and exhaust air systems. Adjust and set all pumps, balancing valves and other flow devices to achieve optimum water distribution in all parts of the circulating water systems.
- 1.4.1.9 Document any deficiencies that prevent the system from being properly balanced and advise the respective installing Subcontractor (Division 21, 22 or 23). Rebalance all affected systems following correction by the respective installing Subcontractor (Division 21, 22 or 23) at no additional cost to the Owner.
- 1.4.1.10 Report on any noise and vibration problems that are discovered during the course of balancing.
- 1.4.1.11 Submit a Balancing Report to the Consultant.
- 1.4.1.12 Repeat the balancing procedures for up to 10% of the system at the request of the Consultant. Should the retest data differ by more than $\pm 5\%$ from the originally reported values, the TAB Contractor shall be obligated to repeat the balancing of the entire system or systems at no additional cost to the Owner, if so requested by the Consultant.
- 1.4.1.13 Include for premium time where schedule requires that TAB work be undertaken after hours.

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1.5 CO-ORDINATION

1.5.1 The respective installing Subcontractor (Division 21, 22 or 23) shall be responsible to ensure that all systems are complete and ready for testing, balancing and adjusting by the TAB Contractor. The respective installing Subcontractor (Division 21, 22 or 23) shall:

1.5.1.1 Confirm the complete operational readiness of the building, including sealed walls, doors, and ceilings to allow the balancing to be performed and required pressures to be set and maintained.

1.5.1.2 Allow access to all components requiring testing, balancing, and servicing. This includes permanently installed ladders and catwalks.

1.5.1.3 Maintain a construction schedule that allows the test and balance (TAB) firm to complete contract work prior to occupancy.

1.5.1.4 Verify the installation conformity to the design drawings and specifications.

1.5.1.5 Promptly correct deficiencies of materials and work that may delay completion of the TAB work.

1.5.1.6 Provide operation and maintenance manuals. Manuals must include the following:

1.5.1.6.1 The manufacturers' method for adjusting and setting components for correct operation under actual load conditions.

1.5.1.6.2 The manufacturers' recommended tolerance for maximum and minimum operating conditions.

1.5.1.6.3 The recommended correction or A_k factors, to allow adjustment of flow, rpm, etc.

1.5.1.6.4 A list of spare parts, identification numbers, and diagrams of their proper locations.

1.5.1.6.5 Pressure drops for air and hydronic flows through the component or unit at design flow rate.

1.5.1.7 Start up all HVAC systems, according to the following conditions:

1.5.1.7.1 Proper lubrication of rotating or sliding parts is verified.

1.5.1.7.2 Motors, fans, and all HVAC equipment have the correct rotation.

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- 1.5.1.7.3 Installation of the correct drive (package) is checked.
- 1.5.1.7.4 Belt tension is appropriate for the type of drive.
- 1.5.1.7.5 Vibration isolators and bases are properly installed and are the correct type.
- 1.5.1.7.6 Smoke and fire damper operation (left in full open position) is correct.
- 1.5.1.7.7 Volume and control dampers (left in a neutral or wide-open position) function properly.
- 1.5.1.7.8 Verification that duct-leakage test has been performed and ducts are sealed to the minimum tolerance specified in the Contract Documents.
- 1.5.1.7.9 Verification that all registers, grilles, and diffusers are of the correct type, are properly installed, and are in the open position.
- 1.5.1.7.10 Verification that all terminal boxes are the correct type and are properly installed according to the manufacturer's recommendations.
- 1.5.1.7.11 Verification that motors, starters, and variable speed controllers with overload safety devices are the correct size and are operating properly.
- 1.5.1.7.12 Verification that automatic controls are installed correctly and include all components specified, including interlocks, freeze stats, damper controllers, minimum positioning switches, control valves, actuators, and sensors.
- 1.5.1.7.13 Verification that hydronic pumps and related components are properly installed and operate correctly.
- 1.5.1.7.14 Verification that strainers are clean and that the system is vented and free of air.
- 1.5.1.7.15 Verification that expansion tanks are properly installed and working.
- 1.5.1.7.16 Verification that coils are piped correctly and are clean.
- 1.5.1.7.17 The motor, amps, volts, and rpm, are compared with nameplate data and are adjusted within a motor-rated hp or amperes.

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- 1.5.1.7.18 Verification that fan and pump power and speed are within design range.
- 1.5.1.7.19 Verification that the controls are complete and operational.
- 1.5.1.7.20 Verification of the correct type, quantity, and cleanliness of installed filters.
- 1.5.2 During testing and balancing; the respective installing Subcontractor (Division 21, 22 or 23) shall:
 - 1.5.2.1 Operate and maintain all systems requiring balancing during the balancing period.
 - 1.5.2.2 Ensure that the control system responds to the testing and balancing requirements. Provide all necessary personnel, equipment and software to make adjustments to controls as required to achieve design condition.
 - 1.5.2.3 Furnish and install drives and motors as required to accomplish design requirements.
 - 1.5.2.4 Provide all equipment, labour, instruments and incidentals and pay for all power and fuel to carry out the tests.
- 1.5.3 Start-Up Report:
 - 1.5.3.1 The Contractor shall provide a copy of a detailed start-up report, including initial tabulated data required for the start-up of systems, to the test and balance agency for reference in the balancing work.
- 1.5.4 Joint effort of Contractors:
 - 1.5.4.1 Upon completion of balancing, the TAB Subcontractor shall provide flows, pressures, and temperatures to the control contractor for final calibration of the automatic control system. The Division 25 – Integrated Automation Subcontractor shall provide access to computerized data and equipment and/or provide operating personnel.
 - 1.5.4.2 After balancing, the TAB Subcontractor shall provide water flow rates, etc. to the chiller, cooling tower, and boiler suppliers for final setup and performance verification.

2 PRODUCTS

Not Used

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3 EXECUTION

3.1 GENERAL

3.1.1 TAB work shall be undertaken in accordance with the following descriptions. Procedures not specifically described herein or requiring amplification shall be in accordance with CAABC / NBCTA / NEBB standards, as applicable.

3.2 AIR SYSTEM BALANCING

3.2.1 Air quantities in main ducts shall be measured by Pitot tube traverses of the entire cross section area of the duct. Openings in ducts for Pitot tube insertion shall be sealed with approved plugs. Outlet and inlet air quantities shall be determined in accordance with CAABC / NBCTA / NEBB procedures.

3.2.2 Total air quantities shall be obtained by adjustment of fan speeds. Branch duct air quantities shall be adjusted by volume dampers. Damper positions shall be permanently marked after TAB work is complete.

3.2.3 For systems handling outdoor air, the system shall be balanced at the normal minimum outdoor air condition. Where the system is designed to deliver 100% return air or a variable amount of outdoor air, the total airflow tests shall be repeated for 100% maximum outdoor air and shall agree with conditions measured under minimum outdoor air operation before the system is considered to be in balance.

3.2.4 Adjusting of individual outlets shall be performed as per CAABC / NBCTA / NEBB procedures or as otherwise approved by the Consultant. Outlets shall be set for the air pattern required and all main supply air dampers shall be adjusted and set for the design indicated. All required changes in air patterns or setting necessary to achieve correct air balance and to minimize drafts shall be performed by the TAB Subcontractor.

3.2.5 All measured air quantities shall be within $\pm 5\%$ of design air quantities where achievable.

3.2.6 The TAB Subcontractor shall perform the test and compile the data required. In addition to the tabulation forms, the TAB Subcontractor shall provide schematic diagrams showing all system components cross-referenced to form tabulations. The lists provided hereinafter shall be considered minimum requirements.

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All information required to prove system balance shall be provided by the TAB Subcontractor.

3.2.7 Air Handling Equipment Tests and Data

3.2.7.1 Tabulate design conditions from documents and installed conditions from shop drawings:

3.2.7.1.1 Fan, unit or system number.

3.2.7.1.2 Location.

3.2.7.1.3 Area served.

3.2.7.1.4 Manufacturer, model and serial number of air unit, motor(s), pulley and belts.

3.2.7.1.5 Motor nameplate power (kilowatts), amperage, voltage, phase, hertz, frame type, and service factor.

3.2.7.1.6 Sheave Manufacturer, model number, grooves, and pitch diameter, adjustable or fixed. Include pitch diameter settings on adjustable sheaves.

3.2.7.1.7 Fan and motor rpm.

3.2.7.1.8 Fan or unit static pressure profile. Measure and record pressure differentials across coils, filters, dampers, etc.

3.2.7.1.9 Total airflow, Outdoor Air, Return Air, Exhaust Air, Relief Air, and Outlet Air (Maximum and Minimum).

3.2.7.1.10 Terminal Manufacturer and type.

3.2.7.1.11 Outlet or inlet size, effective area and A_k Factor, except when using a direct reading flow hood.

3.2.7.1.12 Design temperature differences.

3.2.7.1.13 Design brake horsepower (kilowatts).

3.2.7.1.14 Check that stratification has been eliminated before taking measurements. Make temperature traverse readings after each mixing compartment. Advise the Division 23 – HVAC Subcontractor if any stratification is present.

3.2.7.2 Tabulate from equipment field tests.

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- 3.2.7.2.1 Fan and motor rpm.
- 3.2.7.2.2 Motor amperage for each phase.
- 3.2.7.2.3 Voltage for each phase.
- 3.2.7.3 Tabulate from air data from field test (for each required condition).
- 3.2.7.3.1 Total air quantity for each outlet or inlet and for Supply air, Return Air, Exhaust Air, Relief Air and Outdoor Air for each system.
- 3.2.7.3.2 Pressure reading at most distant point of system (Pa / mm w.g. for VAV systems only).
- 3.2.7.3.3 Pressure drops across filters, boxes, coils and air-to-air heat exchangers.
- 3.2.7.3.4 Supply, Return and Exhaust fan pressure differentials.
- 3.2.7.3.5 Temperature differences across coils and air-to-air heat exchangers.
- 3.2.7.3.6 Traverse locations and grid with actual velocities. Record duct static pressure at each traverse location. Provide traverses at all points necessary for balancing.
- 3.3 WATER SYSTEM BALANCING
- 3.3.1 Water flows shall be balanced by venturi and calibrated orifices with portable type flow meters, where provided by the respective installing Subcontractor (Division 21, 22 or 23), or calibrated meters provided by the TAB Subcontractor.
- 3.3.2 Pump flow capacities shall be determined by venturies, orifices, or multi-duty valves. All settings of balancing valves shall be permanently marked after balance is complete.
- 3.3.3 The TAB Subcontractor shall compare design documents with the shop drawings. If discrepancies are found, TAB Subcontractor shall submit a request for information to resolve the discrepancies.
- 3.3.4 Pump Test and Data.
- 3.3.4.1 Tabulate tests and data: (Confirm in field)
- 3.3.4.1.1 Pump number and service.

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- 3.3.4.1.2 Location.
- 3.3.4.1.3 Area served and type of system served.
- 3.3.4.1.4 Manufacturer, model, serial number of pump.
- 3.3.4.1.5 Motor nameplate power (watts), amperage, voltage, phase, Hertz, frame type and service factor.
- 3.3.4.1.6 Pump and motor rpm.
- 3.3.4.1.7 Pump suction and discharge pressure at operating conditions.
- 3.3.4.1.8 System flow.
- 3.3.4.2 Tabulate from field tests:
 - 3.3.4.2.1 Pump and motor rpm.
 - 3.3.4.2.2 Motor amperage for each phase.
 - 3.3.4.2.3 Voltage for each phase.
- 3.3.4.3 Tabulate from pump field test:
 - 3.3.4.3.1 Total flow.
 - 3.3.4.3.2 Discharge and suction pressure for operating and shut off conditions.
- 3.4 **DEMONSTRATION**
 - 3.4.1 At the request of the Consultant, the TAB Subcontractor shall repeat the balancing procedure for any system or portion of a system. The TAB Subcontractor shall repeat the balancing procedure on 10% (as selected by the Consultant) of systems. If the data is within $\pm 5\%$ of the reported data, the system shall be considered acceptable and the report accepted. If the data is not within $\pm 5\%$ of the reported data, the Consultant can request that the entire system or systems be rebalanced.
- 3.5 **REPORTS**
 - 3.5.1 Submit written reports, during the course of construction, of potential developing problems relating to the work being provided under other sections of the specifications where such problems may adversely affect the proper balancing of the equipment or

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systems.

- 3.5.2 Submit written reports for review upon completion of each major phase of the balancing work.
- 3.5.3 The TAB Subcontractor shall prepare and submit three (3) copies of the Balancing Report to the Consultant for review and evaluation prior to final acceptance of the project. The Balancing Report shall include the data outlined above, but may be expanded or modified to be compatible with the requirements of the installed equipment and systems.
 - 3.5.3.1 The cover of the TAB Report must show the “CAABC / NBCTA / NEBB” Logo, Name and Address of the project, Architect, Mechanical Engineer, Installing Contractor, Date the report is issued, Address and Phone Number of the TAB Subcontractor. The CAABC / NBCTA / NEBB Seal and Signature of the TAB Supervisor who is in charge of the reported project must be submitted on the “Certification” Report Form (TAB 2-98)
 - 3.5.3.2 Identification of all types of instruments used and their last dates of calibration shall be submitted with the Final Report.
 - 3.5.3.3 Once the Consultant’s comments have been incorporated in the report, submit four (4) copies of the Final Report to the Consultant.
- 3.6 QUALITY ASSURANCE
 - 3.6.1 The Tab Subcontractor shall guarantee that all work will be performed in accordance with the applicable CAABC / NBCTA / NEBB Standards and Procedures. The TAB Subcontractor’s Certification Number must be provided to the Consultant.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.1.2 All insulation shall comply with minimum R-value requirements listed in ASHRAE Energy Standard 90.1, 2013 edition, as well as the National Energy Code of Canada for Buildings (NEBC compliance path under OBC SB-10).

1.1.3 All insulation materials and installation must meet the requirements of applicable codes and standards, and be appropriately labeled.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Piping insulation.

1.2.1.2 Equipment insulation, including tanks.

1.2.1.3 Breeching insulation.

1.2.1.4 Engine exhaust insulation.

1.2.1.5 Thermal duct insulation.

1.2.1.6 Adhesives, tie wires, tapes.

1.2.1.7 Recovery jackets.

1.3 SUBMITTALS

1.3.1 Submit Shop Drawings for:

1.3.1.1 Insulation products.

1.3.1.2 Recovery jackets.

1.3.1.3 Adhesives and sealants.

1.3.2 Submittal to include product description, manufacturer's installation instructions, and appropriate specification compliance.

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- 1.3.3 Submit samples of all insulation materials to the Consultant mounted on a board, and labeled for intended services, including 'k' factors. Obtain the Consultant's comments prior to ordering insulation and proceeding with the installation.

2 **PRODUCTS**

2.1 INSULATION MATERIAL

- 2.1.1 Unless otherwise noted, insulating materials are based on Knauf Fiber Glass GmbH.
- 2.1.2 All insulation materials, adhesive sealants and coatings, shall be ULC listed, non-hygroscopic, and mould-proof. Insulation products shall not contain asbestos, lead, mercury, mercury compounds, or formaldehyde.
- 2.1.3 All insulation system materials inside the building must meet the requirements of NFPA 90A, with a flame spread rating of less than 25, and smoke developed rating of less than 50, when tested in accordance with CAN/ULC-S102. Insulation materials shall not flame, smolder, glow or smoke at their service temperatures.
- 2.1.4 Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795. Insulation materials applied to carbon steel shall be Mass Load Corrosion Rate (MLCR) tested per ASTM C 1617.
- 2.1.5 Pipe insulation: Knauf Earthwool™ 1000° glass mineral wool pipe insulation, UL/ULc classified, rigid, molded, k value: 0.033 (0.23) at 24°C (75°F) mean temperature; 0.049 (0.34) at 149°C (300°F) mean temperature. Maximum service temperature 538°C (1000°F). Vapor retarder jacket: ASJ+ conforming to ASTM C 1136 Type I, II, III, IV, & VIII secured with self-sealing longitudinal laps and matching ASJ+ butt strips.
- 2.1.6 Semi-rigid pipe and tank insulation: Knauf Pipe & Tank glass mineral wool insulation, limited combustible, k value: 0.036 (0.25) at 24°C (75°F) mean temperature. Maximum service temperature 454°C (850°F). Compressive strength: not less than 5.75 kPa (120 PSF) @ 10% deformation per ASTM C 165. Vapor retarder jacket: ASJ conforming to ASTM C 1136 Type II.
- 2.1.7 Semi-rigid blanket for equipment: Knauf KwikFlex™ glass mineral wool; in roll form, k value: 0.035 (0.24) at 24°C (75°F) mean temperature; 0.056 (0.39) at 149°C (300°F) mean temperature.

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Maximum service temperature 454°C (850°F), maximum surface temperature for faced product: 66°C (150°F), maximum thickness @ 454°C (850°F): 102mm (4"). Compressive strength: not less than 1.2 kPa (25 PSF) @ 10% deformation per ASTM C 165. Vapor retarder jacket: ASJ, FSK or PSK conforming to ASTM E 96, Procedure A.

- 2.1.8 Fitting insulation: insulate using pre-formed PVC fitting covers with glass mineral wool inserts. Alternatively, preformed molded, formaldehyde free glass mineral wool; minimum 50% post-consumer recycled glass content, or mitered glass mineral wool pipe insulation sections. These fittings shall be further protected by field-applied PVC fitting covers, metal fitting covers, or glass fabric and mastic sealed as necessary.
- 2.1.9 Duct wrap: Knauf Friendly Feel® glass mineral wool blanket; flexible, limited combustible, k value: 0.042 (0.29) at 24°C (75°F) mean temperature. Maximum service temperature: faced 121°C (250°F), unfaced 177°C (350°F). Maximum allowable compression is 25%. Density: concealed areas: minimum 12 kg/m³ (0.75 PCF); exposed areas: minimum 16 kg/m³ (1.0 PCF). Vapor retarder jacket: FSK or PSK conforming to ASTM C 1136 Type II.
- 2.1.10 Rigid duct insulation: Knauf Insulation Board, rigid glass mineral wool board. Maximum service temperature 232°C (450°F). Concealed areas: Density: Minimum 48 kg/m³ (3 PCF). k value: 0.033 (0.23) at 24°C (75°F) mean temperature. Vapor retarder jacket: ASJ conforming to ASTM C 1136 Type I, or FSK or PSK conforming to ASTM C 1136 Type II. Exposed Areas: Density: Minimum 96 kg/m³ (6 PCF). k value: 0.032 (0.22) at 24°C (75°F) mean temperature. Vapor retarder jacket: ASJ conforming to ASTM C 1136 Type I, or FSK or PSK conforming to ASTM C 1136 Type II in combination with protective jacket where necessary.
- 2.1.11 Factory applied jackets:
 - 2.1.11.1 All service jacket with advanced closure system self-sealing lap (ASJ+). All service jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film layer leaving no paper exposed.; conforming to ASTM C 1136 Type I, II, III, IV, and VIII; vapor retarder; with a self-sealing adhesive.
 - 2.1.11.2 All service jacket (ASJ). White kraft paper bonded to aluminum foil and reinforced with glass fibers; conforming to ASTM C 1136;

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vapor retarder.

- 2.1.11.3 Foil scrim kraft (FSK). Aluminum foil, fiberglass reinforced scrim with kraft backing; conforming to ASTM C 1136 Type 1; vapor retarder.
- 2.1.11.4 Poly scrim kraft (PSK). Metalized polypropylene, fiberglass reinforced scrim with kraft backing; conforming to ASTM C 1136 Type 1; vapor retarder.
- 2.1.11.5 Redi-Klad Jacket: VentureClad 5-ply weather and abuse resistant with self-seal lap, zero permeability per ASTM E 96-05; puncture resistance 35.4 kg (189.3 N) per ASTM D 1000; tear strength 19.4 N (4.3 lbs) per ASTM D 624; thickness 14.5 mils (0.0145"); tensile strength 306 N (31 kg)/25 mm (68.0 lb./inch) width.
- 2.1.12 Field applied jackets:
 - 2.1.12.1 PVC: Proto Corporation 25/50 or Indoor/Outdoor, UV resistant fittings, jacketing and accessories, white or colored. Fitting cover system consists of pre-molded, high-impact PVC materials with glass mineral wool inserts. Glass mineral wool insert has a thermal conductivity (k value) of 0.037 (0.26) at 24°C (75°F) mean temperature. Closures: stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.
 - 2.1.12.2 Aluminum Jacket: Alloy 3003 or 3105, minimum thickness per ASTM C 1729, smooth, corrugated or stucco embossed with factory-applied moisture barrier. Overlap shall be 50mm (2 inch) minimum. Jacket shall be banded in place with 12mm x 5mm (½" x 0.20") aluminum strapping fastened with aluminum wing seals.
 - 2.1.12.3 Stainless Steel Jacket: T-304, minimum per ASTM C 1729, smooth, corrugated or embossed with factory-applied moisture barrier. Overlap shall be 50mm (2 inch) minimum. Jacket shall be banded in place with 10mm x 5mm (⅜" x 0.20") aluminum strapping fastened with stainless steel wing seals.
 - 2.1.12.4 Laminated Self-Adhesive Water and Weather Seals: permanent acrylic self-adhesive system; weather resistant, high puncture and tear resistance; meeting or exceeding requirements of UL 723; and applied in strict accordance with manufacturers' recommendations.
 - 2.1.12.5 Canvas jackets: 1.83kg/m2 (6oz./sq.ft) plain weave cotton fabric sealed with dilute fire retardant, waterproof, ULC listed lagging adhesive.

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- 2.1.13 Jacketing for outdoor ductwork
 - 2.1.13.1 Aluminum Jacket: 0.406mm (0.016 inch) thick in smooth, corrugated, or embossed finish with factory applied moisture barrier. Overlap shall be 50mm (2 inch) minimum.
 - 2.1.13.2 PVC Jacket: Proto Corporation Indoor/Outdoor, UV resistant, white. Closure shall be solvent weld adhesive or per manufacturers' recommendations.
 - 2.1.13.3 Laminated Self-Adhesive Water and Weather Seals: applied per manufacturer's recommendations.
- 2.1.14 Mastics:
 - 2.1.14.1 Vapor Retarder Mastics: Knauf Insulation EXPERT Mastics: KI-900 ASJ or KI-905 ASJ+; water vapor permeance: 0.026 metric perm (0.04 perm) at 40 mil dry film thickness. Service Temperature Range: -29°C to 82.2°C (-20°F to 180°F). Color: White
 - 2.1.15 Weather Barrier Mastics: Knauf Insulation EXPERT Mastics: KI-700 ASJ or KI-705 ASJ+; water vapor permeance: 1.2 metric perm (1.8 perm). Service Temperature: -17.8°C to 82.2°C (0°F to 180°F) constant; -29°C to 93°C (-20°F to 200°F) intermittent. Solids: 58% by weight; 50% by volume. Color: White
- 2.1.16 Tapes:
 - 2.1.16.1 ASJ Tape: Knauf Insulation EXPERT ASJ Tape or ASJ+ Tape. Width: 75mm (3 inches) or 102mm (4 inches). Thickness (Total): 0.36 mm (14.3 mil) – ASJ; 0.34mm (13.3 mil) – ASJ+. Adhesion: >840 N/m (4.8 Lbf / in.)
 - 2.1.16.2 FSK Tape: Knauf Insulation EXPERT FSK Tape. Width: 75mm (3 inches) or 102mm (4 inches). Thickness (Total): 0.34mm (13.3 mil). Adhesion: 1,138 N/m (6.5 Lbf / in.)
 - 2.1.16.3 Aluminum Foil Tape: Knauf Insulation EXPERT 2 Mil Foil Tape. Width: 75mm (3 inches) or 102mm (4 inches). Thickness (Total): 0.19mm (7.3 mil). Adhesion: 700 N/m (4.0 Lbf / in.)
- 2.2 APPLICATION
 - 2.2.1 The following areas are designated as “exposed” where the term is applied to covering:

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- 2.2.1.1 Mechanical and electrical equipment rooms, penthouses, parking garage, loading dock, shipping/receiving areas.
- 2.2.1.2 Mechanical plenum spaces.
- 2.2.1.3 Below suspended ceiling level in occupied areas or below slab where no ceiling occurs.
- 2.2.1.4 Duct shafts and/or pipe shafts serviced via "walk-in" type access doors.
- 2.2.1.5 Crawl spaces, tunnels.
- 2.2.2 Cover duct and pipes exposed to weather or dampness with 75mm (3") thick insulation and a final application of tape adequately overlapped to render it water tight. The following areas are designated as "exposed to weather or dampness" and are applicable for this treatment:
 - 2.2.2.1 Air intake, relief, and exhaust plenums directly connected to the outside of the building.
 - 2.2.2.2 Underground service trenches.
 - 2.2.2.3 Buried below ground level.
 - 2.2.2.4 Areas subject to high humidity.
 - 2.2.2.5 Ductwork and piping exposed on the roof.
- 2.3 COLD PIPING
 - 2.3.1 Cover 'cold' piping (operating temperature below 16°C/61°F) with rigid pipe insulation with factory applied vapour barrier jacket and aluminum foil vapour barrier with self-sealed lap. Butt joints sealed with butt strips or aluminum tape. Recover pipe in exposed areas with field applied jacket.
 - 2.3.2 Insulation thickness shall be as follows:
 - 2.3.2.1 25mm (1")
 - unburied domestic cold water piping
 - chilled drinking water
 - unburied apparatus drains

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- horizontal unburied rain water piping, including the piping up to and including roof hoppers or drain fixtures
- horizontal unburied sanitary drains
- cast iron fittings on transite rainwater piping
- gray water piping
- fire standpipe, wet sprinkler and drainage piping in loading dock, parking garage and other unheated areas
- refrigerant suction piping
- auxiliary water piping on refrigeration compressors
- cooling tower make-up water, overflow, bleed and drain pipes inside and outside building
- chilled water/glycol supply and return at 5°C (41°F) and above
- condenser water used for low temperature cooling (water side free cooling) inside building

2.3.2.2 40mm (1-½") - chilled water/glycol supply and return below 5°C (41°F) for pipes greater than DN25 (1") dia.

2.3.2.3 50mm (2") - electrically traced piping, including drum drips of dry sprinkler system

2.3.3 Cover 'cold' piping running outside the building envelope with insulation thickness as follows:

2.3.3.1 65mm (2-½") - pipes up to and including DN50 (2") dia.

2.3.3.2 80mm (3") - pipes DN65 (2-½") up to and including DN100 (4") dia.

2.3.3.3 90mm (3-½") - pipes above DN100 (4") dia.

2.3.4 In lieu of the above specified insulation, Armstrong AP/Armaflex flexible elastomeric expanded closed-cell insulation with same

thickness may be substituted for the following services:

- horizontal unburied rain water piping, including the piping up to and including roof hoppers or drain fixtures
- horizontal unburied sanitary drains
- refrigerant suction piping, 16mm ($\frac{5}{8}$ ") thickness
- auxiliary water piping on refrigeration compressors

2.4 HOT PIPING

2.4.1 Cover 'hot' piping – heating water/glycol, domestic hot water supply and recirculation, condenser water, hot-gas bypass, drip and blowdown lines, steam and condensate, at operating temperatures above 41°C/106°F – with rigid pipe insulation with factory applied kraft paper jacket bonded to aluminum foil vapour barrier with self-sealed lap. Hold insulation in place with flare type staples. Recover pipe in exposed areas with field applied jacket.

2.4.2 Insulation thickness shall be as follows:

2.4.2.1 25mm (1") - 'hot' piping up to 60°C (140°F) operating temperature, for pipes less than 40mm (1-1/2") dia.

2.4.2.2 40mm (1-1/2") - 'hot' piping up to 60°C (140°F) operating temperature, for pipes equal to or greater than 40mm (1-1/2") dia.

- 'hot' piping up to 93°C (180°F) operating temperature, for pipes less than 40mm (1-1/2") dia.

2.4.2.3 50mm (2") - 'hot' piping up to 93°C (180°F) operating temperature, for pipes equal to or greater than 40mm (1-1/2") dia.

- electrically traced piping

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2.4.2.4 65mm (2-½") - 'hot' piping up to 121°C (250°F) operating temperature, for pipes less than 40mm (1-1/2") dia.

2.4.2.5 80mm (3") - 'hot' piping up to 121°C (250°F) operating temperature, for pipes equal to or greater than 40mm (1-1/2") dia.

2.4.3 Cover 'hot' piping running outside the building envelope with insulation thickness as follows:

2.4.3.1 65mm (2-½") - pipes up to and including DN50 (2") dia.

2.4.3.2 80mm (3") - pipes DN65 (2-½") up to and including DN100 (4") dia.

2.4.3.3 90mm (3-½") - pipes above DN100 (4") dia.

2.5 DUCTS

2.5.1 Insulate round supply ducts up to 750mm (30") diameter and rectangular supply ducts up to 750mm (30") width with 25mm (1") thick flexible duct insulation. Adhere insulation to duct surface with adhesive applied in strips 150mm (6") wide on 300mm (12") centres. Use fiberglass tying cord or 16 gauge annealed wire until the adhesive sets. Butt edges of insulation tightly together, and seal all breaks and joints with self-adhering aluminum tape.

2.5.2 Insulate round supply ducts over 750mm (30") diameter and rectangular supply ducts over 750mm (30") width with 25mm (1") thick rigid duct insulation board. Fasten the insulation with welded pins and speed washers on maximum 300mm (12") centres. Use a minimum of two (2) rows of fasteners per side. Butt edges of insulation tightly together, and seal all breaks and joints with self-adhering aluminum tape.

2.5.3 Where angles or standing seams extend beyond the insulation and before the final finish, apply a compressed layer of 25mm (1") flexible duct insulation over the angles and standing seams. Extend the insulation 75mm (3") on each side of the angle and place tightly around the projecting leg of the angle. Apply the insulation overlapping the edge so that the vertical part of the insulated angle will project throughout the work.

2.5.4 Where interior acoustic insulation is required, decrease the exterior insulation by equal thickness. Overlap the exterior insulation by at least 300mm (12"), upstream and downstream.

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- 2.5.5 Apply vapour barrier over insulation on cold and dual temperature ducts.
- 2.5.6 Insulate all ductwork running outside the building with 75mm (3") rigid board insulation and weatherproof jacket.
- 2.5.7 Insulate the following duct:
 - 2.5.7.1 Air conditioning supply ducts from apparatus casings to air terminal control units, reheat coils, or duct termination.
 - 2.5.7.2 Tempered air supply ducts in unheated space.
 - 2.5.7.3 Air supply duct downstream of energy/heat recovery ventilators.
 - 2.5.7.4 All rigid supply ducts downstream from air terminal control units, reheat coils and hydronic terminal units.
- 2.5.8 Air intakes and exhaust:
 - 2.5.8.1 Insulate with rigid vapour seal insulation board.
 - 2.5.8.2 Impale the insulation in place with suitable speed washers or clips. Where angles or standing seams extend beyond the insulation, apply a compressed layer of 25mm (1") flexible duct wrap over the angles and standing seams. The wrap shall extend 75mm (3") on each side of the angle and placed tightly around the projecting leg of the angle. Apply the insulation overlapping the edge of the wrap on the angle so that the vertical part of the insulated angle will project throughout the work.
 - 2.5.8.3 Seal all breaks and joints by adhering a 75mm (3") aluminum foil vapour barrier tape with fire retardant adhesive. Cover with canvas adhered with resin base lagging adhesive. Finish with one coat of the same lagging adhesive.
- 2.6 **COLD EQUIPMENT**
 - 2.6.1 Cover 'cold' equipment with 25mm (1") thick Armstrong AP/Armaflex flexible elastomeric expanded closed-cell insulation. Apply to clean and dry surfaces, using 100% Armstrong 520 adhesive coverage on both surfaces to be joined. Use manufacturer's compression fit method of butt joining sheets.
 - 2.6.2 Insulate the following equipment as 'cold' equipment. Finish insulation with two coats of Armaflex Finish. Color selection to be determined.

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- 2.6.2.1 Refrigeration machine evaporators, suction lines, chiller shells, shell ends and sumps, except pre-insulated units
- 2.6.2.2 Water meters and irregular shapes.
- 2.6.2.3 Strainer heads in cold lines.
- 2.6.2.4 Cold water booster pumps.
- 2.6.2.5 Condensation trays.
- 2.6.2.6 Spray pumps, piping, valves, and fittings.
- 2.6.2.7 Flat plate heat exchangers.
- 2.6.3 Provide removable 1.3mm (16 ga.) aluminum sheet metal enclosure with insulation applied as above to inside of cover, for the following 'cold' equipment:
 - 2.6.3.1 Chilled water pumps
 - 2.6.3.2 Chilled water pump suction and discharge guides
 - 2.6.3.3 Condenser water pumps
 - 2.6.3.4 Condenser water pump suction and discharge guides
- 2.6.4 Cover cooling tower sumps (if electrically traced) with 50mm (2") thick semi-rigid fiberglass board insulation with factory applied vapour barrier. Cut and mitre insulation to suit surface contours. Impale insulation on mechanically fastened pins, located at not greater than 300mm (12") centres. Apply expanded metal lath and lace edges with 1.63mm (16 ga.) galvanized annealed wire. Secure insulation and metal lath with speed washers.
 - 2.6.4.1 Recover sumps with 0.5mm (24 ga.) thick sheet aluminum fabricated to the shape of the sump. Mechanically fasten in place with bands, sheet metal screws or pop rivets. All corners shall be square and raw metal edges concealed.
- 2.6.5 Under each dehumidifier and cooling coil drip pan, place 50mm (2") thick foam glass with all joints sealed with cold adhesive cement.
- 2.6.6 Cover chilled water storage tanks with 50mm (2") thick rigid fiberglass board insulation, scored to suit curved surface. Impale insulation on suitable welded fasteners on 300mm (12") centres

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secured in place with speed washers. Recover with field applied jacket.

2.7 HOT EQUIPMENT

2.7.1 Cover 'hot' equipment (for temperatures not exceeding 232°C/450°F) with 50mm (2") thick semi-rigid fiberglass board insulation. The insulation shall be held in place with 19mm ($\frac{3}{4}$ ") metal bands on maximum 450mm (18") centres. For large, flat or irregular surfaces, impale the insulation over suitable welded fasteners on 300mm (12") centres secured in place with speed washers. Lace the metal edges that butt together with 1.63mm (16 ga.) galvanized annealed wire. Insulation shall not be compressed beyond a maximum of 5% at any point. Recover with field applied jacket.

2.7.2 Insulate the following equipment as 'hot' equipment:

2.7.2.1 Converters, shell and tube heat exchangers (including glycol).

2.7.2.2 Domestic hot water tanks and water heaters except pre-insulated units.

2.7.2.3 Refrigeration condensers, except pre-insulated units.

2.7.2.4 Steam ancillaries.

2.7.3 Insulate flat plate heat exchangers with 25mm (1") thick Armaflex insulation. Refer to Paragraph 2.6.1 for details.

3 **EXECUTION**

3.1 APPLICATION

3.1.1 Do not apply insulation before piping ductwork and equipment has been tested and accepted.

3.1.2 All insulation shall be supplied and installed by a qualified insulation applicator in accordance with the latest MICA Commercial and Industrial Insulation Standard.

3.1.3 All insulation shall be applied in full accordance with the insulation manufacturer's recommendations, and shall present a neat professional appearance upon completion.

3.1.4 Apply all insulation in a manner to facilitate replacing and/or servicing of equipment. All insulation for equipment shall be

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removable and reusable.

- 3.1.5 Use insulation, wrapping, vapour barriers and adhesive materials having flame spread, fuel contributed and smoke developed ratings in accordance with rulings and regulations of authorities. Follow all rules, regulations, and instructions of the Fire Marshall's office and all authorities having jurisdiction.
- 3.1.6 Do not apply any insulation or finishing when the ambient temperature in the space is less than 10°C (50°F).
- 3.1.7 Apply insulation only on clean and dry surfaces.
- 3.1.8 On cold surfaces where a vapor seal must be maintained, insulation shall be applied with a continuous, unbroken moisture and vapor retarder. All hangers, supports, anchors, or other projections secured to cold surfaces shall be insulated and vapor sealed to prevent condensation. Wheatpaste must not be used.
- 3.1.9 All pipe insulation shall be continuous through walls, ceiling or floor openings or sleeves except where firestop materials are required.
- 3.1.10 Install multiple layers of insulation with longitudinal and circumferential joints staggered.
- 3.1.11 Galvanized sheet metal shields, minimum 250mm (10") long and 1.3mm (18 gauge) thickness, shall be installed between hangers or supports and the piping insulation. Rigid insulation inserts shall be installed as required between the pipe and the insulation shields. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required. Inserts made of wood are not acceptable. Insulation inserts shall be no less than the following lengths:
 - 3.1.11.1 40mm (1½") to 65mm (2½") IPS 250mm (10") long
 - 3.1.11.2 75mm (3") to 150mm (6") IPS 300mm (12") long
 - 3.1.11.3 200mm (8") to 250mm (10") IPS 400mm (16") long
 - 3.1.11.4 300mm (12") and over IPS 550mm (22") long
- 3.1.12 For piping, ductwork or equipment exposed in mechanical rooms or high traffic areas, insulation shall be protected from abuse by the use of appropriate thickness of PVC jacketing, metal jacketing or laminated self-adhesive water and weather seals.

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- 3.1.13 On boiler breeching, generator exhaust pipes and mufflers stagger half sections and butt one-piece sections firmly together. Recover insulation with glassfiber cloth, adhered with fire retardant and high temperature rated adhesive. Insulation shall be banded securely in place with 20mm x 0.5mm ($\frac{3}{4}$ " x 0.02") stainless steel bands on maximum 300mm (12") centres and recovered with metal jacketing secured using additional banding or sheet metal screws. Position bands at butt joint overlaps and in between joints to secure jacket.
- 3.1.14 Insulate over flanges and mechanical couplings with specified insulation and thickness, sized to suit flange diameters. Fill spaces between insulation and adjoining pipe insulation with similar material. Recover in exposed areas with canvas or PVC jackets.
- 3.1.15 If not using preformed insulation, wrap all valves and inline components in cold piping and in hot piping above 60°C (140°F) operating temperature with flexible duct insulation, under compression at 2 to 1 ratio. Recover in exposed areas with field applied jackets.
- 3.1.16 Cover the first 150mm (6") of hanger rods directly connected to cold piping, with block or sectional insulation. Finish to match jacket on piping. Recover in exposed areas with canvas jacket.
- 3.1.17 Cover all insulated electrically traced piping, and all insulated piping, ductwork or equipment exposed to the outside with weatherproof field applied jacket.
- 3.1.18 Insulate all silencer casings where no internal media contacts wall.
- 3.1.19 All aluminum and PVC recovery jackets shall be removable and reusable.
- 3.1.20 Dampers, supports, anchors, etc. that are secured directly to cold surfaces must be adequately insulated and vapour sealed to prevent condensation.
- 3.1.21 Cover expansion joints first with a 0.7mm (24 gauge) galvanized metal sleeve and then insulate to provide equivalent thickness to that on adjoining pipe.
- 3.1.22 Ensure insulation is continuous through non-fire rated walls and floors. Terminate insulation neatly on either side of a fire rated barrier. Fill space between pipe and construction with fire retardant sealant. Insulation or recovery jacket shall not penetrate fire-rated construction.

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- 3.1.22.1 Outdoor ductwork or insulation shall be installed so as to shed water and not allow standing water.
- 3.1.23 Insulate electrically traced piping and equipment only after pipe tracing has been installed and tested.
- 3.1.24 Repair/replace all insulation damaged during construction with the thickness, quality, and finish of original insulation.
- 3.1.25 Make good and refinish cracks, undulation or any other deficiencies occurring in the insulation or vapour barrier. Priming or painting of insulation will be done under Division 9 – Finishes.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this section.

1.1.2 This Section of the specification shall be read in conjunction with all other Sections of the Division 21, 22, 23 and 25 Specifications, which include details of specific tests / inspections to be performed on various equipment / systems in addition to those specified in this Section.

1.2 COMMISSIONING COORDINATOR

1.2.1 The Owner shall directly employ the services of a Commissioning Coordinator (who will act on behalf of the Owner as the Commissioning Authority) whose responsibilities include:

1.2.1.1 Organize all necessary meetings of the commissioning team, act as chairperson at all commissioning meetings and events, prepare agenda for the events, and issue minutes of meeting.

1.2.1.2 Report to the Owner and Construction Manager on the status, integration, and performance of mechanical systems provided as a part of the Works.

1.2.1.3 Review Contractor's Commissioning Plan.

1.2.1.4 Review shop drawings approved by the Consultants for compatibility with commissioning requirements.

1.2.1.5 Review Commissioning Schedule, prepared, coordinated, and submitted by the Contractor.

1.2.1.6 Ensure that the Contractor successfully conducts all specified and/or necessary tests on systems, equipment, and components during construction and that all tests are recorded by the Contractor for retention as part of Commissioning Documents. Witness or verify tests as appropriate.

1.2.1.7 Review and approve all Commissioning Report Forms, record sheets etc. proposed by the Contractor.

1.2.1.8 Periodically monitor assembly of material for O&M Manuals by the Contractor to ensure timely completion of manuals.

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- 1.2.1.9 Periodically monitor preparation of Record Drawings by the Contractor to ensure timely completion of drawings.
- 1.2.1.10 Monitor progress of commissioning relative to the Commissioning Schedule and periodically report the status, pending problems and/or disputes to the Owner and Construction Manager.
- 1.2.1.11 Witness, check, and verify a percentage of all reported results of commissioning tests and procedures including Testing Adjusting and Balancing (TAB), start-up, verification and Functional Performance Tests (FPT).
- 1.2.1.12 Examine all deviations in test results and in performance, confirm as acceptable or otherwise, and advise Owner and Construction Manager of corrective action required from the Contractor.
- 1.2.1.13 Ensure that all deficiencies discovered during commissioning testing are identified, documented and assessed for their severity and impact on proper system performance and forwarded to the Owner and Construction Manager.
- 1.2.1.14 Review of Final Commissioning Report prepared by the Contractor for completeness including identification of all problems encountered during commissioning and operation phases.
- 1.2.1.15 Review of O&M Manuals prepared by Contractor for completeness and submission to Consultant for approval.
- 1.2.1.16 Review of Record Drawings to ensure that they reflect the approved results of commissioning and submission to Consultant for approval.
- 1.2.1.17 Assist in the scheduling of training for Owner's O&M personnel.
- 1.2.1.18 Ensure completion and documentation of commissioning activities not concluded during the commissioning phase due to seasonal operation constraints or testing which requires long term monitoring and analysis.
- 1.3 **COMMISSIONING CONTRACTOR**
- 1.3.1 The Division 21, 22, 23 and 25 Contractors shall be the Commissioning Contractors (Contractors) for all systems and equipment provided under their respective Divisions.
- 1.3.2 Division 21, 22, 23 and 25 each shall provide a single person to act as a Commissioning Manager for their respective Division. The

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Commissioning Managers shall be responsible for progressing the activities of each Division trade, and report to the Commissioning Coordinator.

1.3.3 Supply the name, qualifications, and experience of the proposed Commissioning Manager to the Commissioning Coordinator prior to commencement of the work. Selection shall be subject to the review and approval of the Commissioning Coordinator. Supply alternate person(s) when requested by the Commissioning Coordinator.

1.4 SCOPE OF WORK

1.4.1 The Contractor shall provide all labour, materials, tools, equipment, documentation, training, and certification required to commission all mechanical systems provided for the Works including, but not limited to, the following:

1.4.1.1 Chilled water generation system.

1.4.1.2 Heating water generation system.

1.4.1.3 Glycol condenser water system.

1.4.1.4 Hydronic distribution systems including pumps.

1.4.1.5 HVAC terminals including heat pump units and perimeter radiation.

1.4.1.6 Air handling / air distribution systems.

1.4.1.7 Washroom exhaust and General exhaust systems.

1.4.1.8 Humidification systems.

1.4.1.9 Water treatment systems.

1.4.1.10 Building Automation System (BAS) and controls.

1.4.1.11 Domestic cold water system.

1.4.1.12 Domestic hot water system.

1.4.1.13 Sanitary drainage system.

1.4.1.14 Storm water drainage system.

1.4.1.15 Steam distribution system.

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- 1.4.1.16 Motor Control Centres.
- 1.4.1.17 Variable Frequency Drives.
- 1.4.1.18 Electric power supplies included under Division 21, 22, 23 and 25's scope.
- 1.4.1.19 Site services.
- 1.4.2 Commissioning work shall include, but not be limited to:
 - 1.4.2.1 Attendance at all Commissioning Meetings.
 - 1.4.2.2 Preparation of Commissioning Plan.
 - 1.4.2.3 Preparation of Commissioning Schedule.
 - 1.4.2.4 Development and completion of Commissioning Report forms and check sheets for each system and piece of equipment.
 - 1.4.2.5 Demonstration to the Owner and Consultant(s) that the equipment/system have been installed per contract documents.
 - 1.4.2.6 Preparation of O&M Manual.
 - 1.4.2.7 Preparation of Record Drawings.
 - 1.4.2.8 Start-up and verification of systems and equipment.
 - 1.4.2.9 Performance testing of equipment.
 - 1.4.2.10 Review and verification of Testing, Adjusting and Balancing work and report.
 - 1.4.2.11 Correction of all deficiencies and performance deviations.
 - 1.4.2.12 Demonstration and training to Owner and Consultant of all systems and equipment provided in this Division.
 - 1.4.2.13 Preparation and assembly of Commissioning Documentation.
 - 1.4.2.14 Coordination of Division 21, 22, 23 and 25 commissioning activities with all other trades.
 - 1.4.2.15 Coordinate with and assist Division 26 – Electrical for Commissioning of Division 26 – Electrical works.
- 1.4.3 Provide qualified personnel and all necessary equipment /

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measuring / recording instruments etc. to perform commissioning tests (including seasonal testing required after the initial testing) and their verification / witnessing by the Commissioning Coordinator.

- 1.4.4 Provide equipment, materials, and labour as necessary to correct construction and/or equipment deficiencies found during the commissioning process. Repeat the necessary tests to the satisfaction of Consultants and the Commissioning Coordinator.
- 1.4.5 Perform detailed testing on all installed equipment and systems to ensure that operation and performance conform to Contract Documents. All tests shall be offered for witnessing by the Commissioning Coordinator and Consultant. Apart from tests and inspections specified elsewhere in this division, perform the following tests as part of the commissioning process:
 - 1.4.5.1 Verification tests including a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems are installed and operate in accordance with Contract Documents. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions.
 - 1.4.5.2 Functional Performance Tests (FPT) to determine if the Mechanical systems provide the required services in accordance with the finalized design intent.
- 1.4.6 Comprehensive training of Owner's O&M personnel shall be performed by the Contractor, and where appropriate, by other sub-contractors, and vendors prior to turnover of building to the Owner. The training shall include on-site familiarization, classroom instruction and with hands-on instruction on the installed equipment and systems. The Contractor shall provide all necessary training material and documents.
- 1.4.7 Provide attendance at the site at minimum once each month from Substantial Completion up to one (1) month after the first year warranty review, at a date and time to be arranged by the Consultant or Commissioning Coordinator. Follow up and rectify deficiencies and other issues raised during this site review.
- 1.4.8 Attend all commissioning meetings organized by the Commissioning Coordinator or Consultant. The meetings will commence no later than two (2) months after award of contract, will be held (as a minimum) once a month during the first half of the

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construction period, and thereafter, the frequency will increase as deemed necessary by the Commissioning Coordinator or Consultant to accomplish timely commissioning.

- 1.4.9 Ensure and pay for attendance at all commissioning meetings by the sub-contractors (including, but not limited to, the sheet metal, piping, sprinkler, BAS and controls, water treatment, TAB sub-contractors) and major equipment suppliers as required by the Commissioning Coordinator or Consultant.
- 1.4.10 Prepare a detailed Commissioning Schedule for commissioning of all mechanical systems and equipment in coordination with the General Contractor's / Construction Manager's schedule and to the approval of Commissioning Contractor. Update the schedule as appropriate through the construction period.
- 1.4.11 Prepare all documents related to commissioning of the mechanical systems. Documentation required as part of the Commissioning process shall include, but not limited to:
 - 1.4.11.1 Commissioning Plan.
 - 1.4.11.2 Commissioning Schedule.
 - 1.4.11.3 Design intent narrative, systems descriptions, Basis of Design including the design criteria, setpoints, design conditions, etc. These documents shall be based, where appropriate, on Division 21, 22, 23 and 25 Specifications, Drawings, approved shop drawings, and input from the Consultant.
 - 1.4.11.4 Completed commissioning check sheets.
 - 1.4.11.5 Independent test reports, including Testing, Adjusting and Balancing (TAB), equipment manufacturers' certification letters, reports from Authorities having jurisdiction (AHJ), etc.
 - 1.4.11.6 Inspection and performance test reports.
 - 1.4.11.7 Operation and Maintenance Manuals.
 - 1.4.11.8 User and Operator Training Manuals.
 - 1.4.11.9 Tender drawing and specifications.
 - 1.4.11.10 Change orders.
 - 1.4.11.11 Record drawings.

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- 1.4.11.12 Permits and licenses.
- 1.4.11.13 Warranties.
- 1.4.11.14 Post occupancy optimization reports.
- 1.4.11.15 Other documents as required.
- 1.4.12 The Commissioning Coordinator may, at their discretion, advise in the commissioning process. Meet all requirements of the Commissioning Coordinator and provide cooperation.
- 1.5 COORDINATION
- 1.5.1 Coordinate the work of this Section with all other Divisions to ensure complete and operational mechanical systems at completion of this work.
- 1.5.2 Review the design intent of the project and the intended operation of systems with the Commissioning Coordinator and Consultant before proceeding with commissioning.
- 1.6 QUALITY ASSURANCE
- 1.6.1 The commissioning process shall meet the requirements of CAN/CSA Z31 series, the Code of Practice for Commissioning Mechanical Systems in Buildings and ASHRAE Guideline 1.1 - 2007 The HVAC Commissioning Process except as specifically modified by this specification.
- 1.7 SPECIALIST COMMISSIONING COMPANY
- 1.7.1 Division 21, 22, 23 and 25 may elect to source start-up and handover by a specialist commissioning company. Supply to the Commissioning Coordinator, the following details regarding the proposed firm:
 - 1.7.1.1 Principle representative and qualifications.
 - 1.7.1.2 Proposed personnel and relevant project experience.
 - 1.7.1.3 Previous similar assignments and references.
 - 1.7.1.4 Scope of work to be undertaken.
 - 1.7.1.5 Company resources and equipment.

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1.7.2 Use of a commissioning specialist shall not relieve Division 21, 22, 23 and 25 Contractors of the obligation to name one of their own employees as the person responsible for progressing commissioning, i.e. the Commissioning Manager.

2 **PRODUCTS**

2.1 INSTRUMENTS

2.1.1 Prior to commencing commissioning activities on site, the contractor shall submit list of all measuring / recording instruments to be used on the project, along with calibration certificates, for Commissioning Coordinator's approval.

3 **EXECUTION**

3.1 SCHEDULE AND COMPLETION OF INSTALLATION OF SYSTEMS

3.1.1 Submit to the Commissioning Coordinator, within 90 days of award of contract, a detailed and comprehensive installation completion / start-up / testing schedule, identifying all trades and suppliers to be involved. Coordinate the schedule with General Contractor's / Construction Manager's overall Construction schedule. Update the schedule and resubmit for review, periodically as required, and on a biweekly basis during the course of commissioning. If found to be unacceptable, revise the schedule and the construction forces to suit the reviewed schedule. This schedule shall include, but is not limited to the following items:

3.1.1.1 Installation and testing of pipe systems.

3.1.1.2 Installation, leak testing, and cleaning of duct systems.

3.1.1.3 Chemical clean out and treatment of pipe systems, including disinfection of domestic water piping.

3.1.1.4 Control system wiring (by Controls Contractor).

3.1.1.5 Electrical works under Scope of Division 21, 22, 23 and 25 Contractors.

3.1.1.6 Air and water balancing (by Balancing Contractor).

3.1.1.7 Electrical service connections (by Electrical Contractor).

3.1.1.8 Equipment suppliers' prestart checkout and certification of the

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equipment installations, including controls.

- 3.1.1.9 Start up of various pieces of equipment and systems.
- 3.1.1.10 Operational testing of system components.
- 3.1.1.11 Performance testing of equipment and systems.
- 3.1.1.12 Acceptance testing of equipment installations and system including fire and sprinkler systems, by authorities having jurisdiction and Owner's insurance company.
- 3.1.1.13 Troubleshooting.
- 3.1.1.14 Calibration of controls and point checkout (by Division 25 Contractor).
- 3.1.1.15 Control software setup and checkout including seasonal and response checkout or operating sequences, PID optimization (By Division 25 Contractor).
- 3.1.1.16 Emergency system checkout.
- 3.1.1.17 Fire alarm and control system interfacing (by Division 25 Contractor & Division 26 - Electrical).
- 3.1.1.18 Submittal of completed equipment and system check sheets.
- 3.1.1.19 Demonstration of systems and equipment.
- 3.1.1.20 Record Drawing preparation and submittal.
- 3.1.1.21 O&M manual preparation and submittal.
- 3.1.1.22 O&M personnel training program.
- 3.1.1.23 Stair pressurization testing.
- 3.1.1.24 Verification / witnessing of commissioning tests and TAB by the Commissioning Coordinator and/or Consultant.
- 3.2 **RECORD DOCUMENTATION**
- 3.2.1 Prepare record documentation for each equipment installation covering:
 - 3.2.1.1 Equipment identification and supplier.

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- 3.2.1.2 Shop Drawing submittal, review, production release, and delivery dates.
- 3.2.1.3 Dates for completion of all work required preparing for equipment installation.
- 3.2.1.4 Dates for equipment installation, supplier prestart checkout, and system availability for start-up.
- 3.2.1.5 Dates for equipment start-up, performance testing, proposal for temporary use, acceptance testing, demonstration, turnover and warranty start / finish.
- 3.2.2 Submit proposed record sheets and procedures to Commissioning Coordinator for review, when requested.
- 3.2.3 List all specialist personnel and equipment required for the tests, and ensure that these are available by the test dates.
- 3.2.4 Provide documentation of the commissioning process and include in maintenance manuals. These are to include check sheets, equipment data sheets, start-up certificates from suppliers involved in start-up, and documentation concerning demonstration to the Owner's O&M Personnel. Include all record and result sheets from commissioning tests.
- 3.2.5 Maintain a log of key operating parameters, problems encountered, solutions employed and verification of effectiveness of solutions. Include log in maintenance manuals.
- 3.2.6 Submit templates for all documentation including record sheets, check sheets, commissioning reports etc to Commissioning Coordinator for approval. Meet Commissioning Coordinator's requirements for level of reporting.
- 3.3 **START-UP**
- 3.3.1 Coordinate and supervise the start-up of the various pieces of equipment and systems. Utilize the start-up services of the manufacturer's representative. Ensure that the equipment is operating in a satisfactory manner. Check the following items:
 - 3.3.1.1 Direction of rotation.
 - 3.3.1.2 Grease and lubricants.
 - 3.3.1.3 Noise, if deemed to be a problem.

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- 3.3.1.4 Seals.
- 3.3.1.5 Alignment of pump and fan drives by a millwright.
- 3.3.1.6 Piping connections and safeties.
- 3.3.1.7 Electrical amp draw, starting inrush current and trip / heater settings.
- 3.3.2 Meet Section 20 00 00 - General Requirements criteria for Temporary Services, Trial Use, and Early Occupancy.
- 3.4 TROUBLESHOOTING
- 3.4.1 Resolve inter-division coordination problems.
- 3.4.2 Where problems become apparent during the commissioning process, identify and resolve these problems. The basic functions in troubleshooting shall include:
 - 3.4.2.1 What – identification and definition of the problem.
 - 3.4.2.2 Why – determination and evaluation of the causes.
 - 3.4.2.3 When – determine the time available to resolve the problem.
 - 3.4.2.4 Involve the Consultant in the review of the problem and proposed resolution, and keep Commissioning Coordinator informed.
 - 3.4.2.5 Coordinate remedial action with the appropriate parties.
 - 3.4.2.6 Evaluate the effectiveness of the remedial action.
 - 3.4.2.7 Record the problem, cause, remedial action, and result.
- 3.5 OPERATION AND TESTING
- 3.5.1 Meet Section 20 00 00 – General Requirements and 20 05 93 – Testing, Balancing and Adjusting requirements for inspection, testing and certificates.
- 3.5.2 Test the operation of the individual components and systems. Go through each step of the sequence of operation and verify that each component operates correctly. Direct and ensure that all trades involved make the required changes and adjustments to effect the proper operation of all components and systems. Meet commissioning test requirements.

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3.5.3 Document operation and testing.

3.5.4 Carry out operational tests for the current season and simulate operation of summer, winter, and intermediate seasons.

3.6 DEMONSTRATION

3.6.1 Demonstrate to the Owner the proper operation of all equipment and systems supplied under this Division. Demonstrations shall occur only after the operation and testing has been successfully completed. Ensure that Trade Contractor and equipment suppliers participate in the demonstration as required.

3.6.2 Meet Section 20 00 00 – General Requirements criteria for instruction to Owners and requirements of Appendix A to this section.

3.7 TRAINING

3.7.1 Organize and provide comprehensive training to the Owner's O&M Personnel on all mechanical equipment, systems and components provided for the Works. Training shall be carried out by the Contractor (and vendors / suppliers where appropriate) to meet the Owner's requirements and this Specification.

3.7.2 Secure and pay for the services of all manufacturer's of major equipment / systems for providing training on their respective systems. Such equipment / systems include:

3.7.2.1 Domestic water boilers

3.7.2.2 BAS and controls.

3.7.2.3 Make-up air units

3.7.2.4 Heat pump units.

3.7.2.5 Chemical treatment system.

3.7.2.6 Humidifiers.

3.7.3 The training shall include:

3.7.3.1 Familiarization sessions organized during the construction and commissioning stages as necessary. The intent of these sessions is to fully familiarize the O&M personnel with the installation.

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- 3.7.3.2 Hands-on training shall be provided on all systems, components and equipment and all commissioning procedures explained. This training shall be provided during the commissioning stage.
- 3.7.3.3 Classroom sessions during the commissioning stage to instruct the O&M personnel in the use of O&M Manuals and other commissioning documentation.
- 3.7.3.4 All classroom training, field training and demonstrations shall be video recorded for future reference. All recordings shall be delivered to the Commissioning Coordinator on DVD format for review with seven (7) days of the session. All recordings shall be formatted to be played on a standard DVD player and include electronic copies of all classroom materials used throughout the training.
- 3.7.4 The Contractor shall prepare all necessary system descriptions, sequence of operation documents, schematic diagrams, control schematics, catalogue cuts, wiring diagrams and similar documents as required for imparting training. As far as practical, the documents should be same as those intended for use in O&M manuals. The Contractor shall compile all training documents and make them available to O&M personnel prior to training and for retention throughout training period.
- 3.7.5 Contractor shall pay for all audio / visual training aids (such as video presentations, slides, projectors and similar equipment) and space for imparting training.
- 3.7.6 The training shall be imparted during normal working hours and the duration shall be as necessary to meet the Owner's requirements, but in any case not less than 15 hours for familiarization and 35 hours for classroom and hands-on sessions.
- 3.7.7 Training for Mechanical Services shall be imparted to up to ten (10) O&M Personnel.
- 3.8 OPERATING AND MAINTENANCE MANUALS
- 3.8.1 Meet requirements of Section 20 00 00 – General Requirements, of this Section, and of Appendix B. Documents such as system description, sequence of operation (including start-up and shut-down procedures) shall be compiled by the Contractor from the specification, drawings and approved shop drawings and included in the manuals after Consultant's approval.

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3.9 RECORD DRAWINGS

3.9.1 Meet requirements of Section 20 00 00 – General Requirements and of this Section.

3.10 SPARE PARTS

3.10.1 Provide a list of spare parts, special tools, lubricants, etc. for each item of equipment, which has been purchased as part of the Contract.

3.10.2 Provide a listing of recommended spare parts for all equipment installed under Division 21, 22, 23 and 25, to cover a period from Substantial Completion to Warranty end.

3.10.3 Provide at minimum, the following information for recommended spare parts:

3.10.3.1 Manufacturer's name, address, phone and fax numbers.

3.10.3.2 Manufacturer's part name, part number, unit price, lead time, shelf life.

3.10.3.3 Quantity recommended for one (1) year.

3.10.3.4 Alternative suppliers of compatible parts, including local supplier name, address, phone and fax numbers.

3.10.4 Submit preliminary list of spare parts and tools to Owner to least 30 days prior to intended system handover to Owner. The Owner reserves the right to add to, reduce, or omit entirely, the recommendations contained on these lists.

3.10.5 Meet requirements of Appendix B.

3.11 COMMISSIONING TESTS

3.11.1 Verify readings, calibration and setup of sensors and equipment, including, but not limited to, the following:

3.11.1.1 Temperature sensors.

3.11.1.2 Freeze protection devices.

3.11.1.3 Flow switches.

3.11.1.4 Status switches.

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- 3.11.1.5 Temperature and pressure gauges and gauge connection utilization.
- 3.11.1.6 Control damper positioning, including tightness when closed and full open / balance position.
- 3.11.1.7 Alarm contacts.
- 3.11.1.8 Pressure sensors.
- 3.11.1.9 Refrigerant sensors.
- 3.11.2 Verify correct sensors are reporting accurately to the distributed field panels and operator workstation.
- 3.11.3 Operate chiller and verify operation including, but not limited to, the following:
 - 3.11.3.1 Full checkout by manufacturer's start-up representative.
 - 3.11.3.2 Start / stop from local MCC and from BAS.
 - 3.11.3.3 Chilled water temperature control.
 - 3.11.3.4 Safety interlocks.
- 3.11.4 Operate each air handling unit. Verify operation with respect to sequence of operation. As a minimum, verify the following:
 - 3.11.4.1 Start / stop from local panel and BAS terminal.
 - 3.11.4.2 Correct open / close and modulation procedures with valves and dampers.
 - 3.11.4.3 Stable operation of controls under normal conditions and with changes in air / water / on / off conditions.
 - 3.11.4.4 Trend logs operation indication.
 - 3.11.4.5 Piping, sensor, and unit installation.
 - 3.11.4.6 Filters.
 - 3.11.4.7 Drain pan operation and trap priming.
 - 3.11.4.8 Alarm indications.
- 3.11.5 Verify operation of condenser water system and support systems,

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including, but not limited to, the following:

- 3.11.5.1 Full checkout by manufacturer's start-up representatives.
- 3.11.5.2 Makeup water system.
- 3.11.5.3 Condenser water pumps with sequence of operation and flow rates.
- 3.11.6 Verify operation of heated water and chilled water pumps and support systems, including, but not limited to, the following:
 - 3.11.6.1 Full checkout by manufacturer's start-up representative.
 - 3.11.6.2 Temperature control stability.
 - 3.11.6.3 Strainer and filter performance.
 - 3.11.6.4 Pumping.
- 3.11.7 Verify pipe cleaning and chemical treatment condition for all systems.
- 3.11.8 Verify duct cleaning, air and water balancing and air pattern adjustments.
- 3.11.9 Verify access to each fire damper.
- 3.11.10 Verify that all cooling coil drain pans and condensate piping operate.
- 3.11.11 Verify backflow preventer operation.
- 3.11.12 Verify operation of fire protection system including flow switches and supervisory switches.
- 3.11.13 Demonstrate access to all valves, equipment, and components for servicing.
- 3.11.14 Verify operation of domestic cold water system including full checkout by booster pump manufacturer's start-up representative. Verify flow at sanitary fixtures.
- 3.11.15 Verify operation of domestic hot water system including temperature control stability and flow at sanitary fixtures.
- 3.11.16 Verify the operation of all other equipment provided under Division

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21, 22, 23 and 25.

- 3.11.17 Verify that interfacing to the work of other Divisions results in complete and operational systems.
- 3.11.18 Test all individual equipment and system responses to power fluctuations and interruptions.
- 3.11.19 Test the ability of the BAS system to perform a power fail restart of the systems effectively and in coordination with the electrical system to prevent electrical system overloading. (This depends on the electrical system response and degree of BAS monitoring.)
- 3.11.20 Test redundant systems to ensure they provide the required back-up in the event of a primary system failure.
- 3.11.21 Test the system response to the loss of communication between the various levels of control system architecture.
- 3.11.22 Test the system response to the loss of cooling.
- 3.11.23 Test the system response to the loss of heating.

3.12 FUNCTIONAL PERFORMANCE TESTS

- 3.12.1 Carry out, record, document and offer for witnessing all measurements necessary to determine the capacity of all heating / cooling equipment and heat exchangers provided for the works including, but not limited to, the following:
 - 3.12.1.1 Boilers.
 - 3.12.1.2 Each type and model of heat pump units.
 - 3.12.1.3 Cooling and heating coils of air handling units.
- 3.12.2 Contractor shall include for all costs related with simulating the internal loads if necessary and/or for deferring the tests to the appropriate season. However all tests must be completed satisfactorily within twelve (12) months of substantial completion.
- 3.12.3 Measure and record the temperature in all occupied spaces of the Works. Also record the setpoint temperatures. Measurements shall be carried out on two occasions within the first year of operation at times to be determined by the Commissioning Coordinator; once during summer and once during winter.

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- 3.12.4 Rectify any deficiencies noted in the above tests and include comprehensive report in the commissioning documents.
- 3.12.5 Contractor shall employ the services of the TAB contractor to carry out the FPT's. TAB contractors scope as defined in Section 20 05 93 - Testing, Balancing and Adjusting shall be extended to include these works.
- 3.12.6 Ensure all other performance tests specified elsewhere in the specifications (including, but not limited to, sound levels and vibrations) are carried out at this stage, offered for witnessing and all test sheets are included in the commissioning documents.
- 3.13 **SITE ACCEPTANCE TESTING FOR BAS & CONTROLS**
 - 3.13.1 In addition to the tests / demolition specified under Division 25 and elsewhere in this Section, the following requirements apply for BAS and Control system:
 - 3.13.1.1 Perform a complete demonstration of the BAS real-time responsibilities of surveillance and command prior to online operation.
 - 3.13.1.2 Advise the Commissioning Coordinator, Consultant, and Owner, in writing, at least two (2) weeks in advance of readiness to perform tests.
 - 3.13.1.3 Note deficiencies and correct starting and continuing tests. Perform calibration and operational checks prior to the commencement of final acceptance testing for all relevant system parts.
 - 3.13.1.4 Perform final acceptance testing at the following defined levels:
 - 3.13.1.4.1 Per point basis.
 - 3.13.1.4.2 Per system basis.
 - 3.13.1.4.3 Software functions and packages basis.
 - 3.13.1.4.4 Per building basis.
 - 3.13.1.4.5 Total BAS basis.
 - 3.13.1.5 Make available on site for the duration of these tests, all installation, engineering, software, system and personnel, required to enable test completion.

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- 3.13.1.6 Demonstrate the specified performance of the BAS software and hardware, at all levels from individual end devices through to total system operation and the proper operation / undertaking of all other items of work performed under this Contract.
- 3.13.1.7 Specifically orient acceptance test procedures to demonstrate the satisfactory operation of aspects of the operator interface terminals.
- 3.13.1.8 Perform and complete and detailed calibration and operational check for each individual BAS point and control function contained within the supplied system. Check to ensure that all equipment, software, network elements, modules and circuits provided are functioning to meet the Specification and record on long sheets.
- 3.13.1.9 Randomly test the response to the following sensor failures:
 - 3.13.1.9.1 Space temperature.
 - 3.13.1.9.2 Fluid temperature (air and water).
 - 3.13.1.9.3 Flow sensor (air and water).
 - 3.13.1.9.4 Pressure sensor (air and water).
- 3.13.1.10 Repeat acceptance testing until acceptance performance has been established.
- 3.14 POST SUBSTANTIAL PERFORMANCE VISITS
 - 3.14.1 Visit the site and the Owner's representative with the Consultant each month after Substantial Completion up to one (1) month after the first year warranty review.
 - 3.14.2 Review the operation of the system.
 - 3.14.3 Correct any operating problems, if problem is related to warranty issues, and follow up on deficiencies and other issues raised.
 - 3.14.4 Prepare a report for the Consultant and Construction Manager for inclusion in the Operating Manuals of the problems and issues that have arisen and the corrective action(s) recommended and implement.

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END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Variable frequency drives (VFDs).

1.2.1.2 Line filters

1.2.2 Power wiring from power supply to each VFD shall be by Division 26 - Electrical. Power wiring from the VFDs to the motors shall be provided by Division 26 - Electrical.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for VFDs, including performance data, dimensions, shipping section dimensions, weight, control schematics, external connection diagram showing function and identification of all terminals requiring field connections.

1.3.2 Provide operating and maintenance information and commissioning report prepared by authorized manufacturer's representative.

1.3.3 Manufacturer shall submit a computerized harmonics analysis of the facility system based on the most recent single line diagram. Analysis shall illustrate the effect of VFDs on system harmonics.

1.4 ELECTRICAL EQUIPMENT AND WORK

1.4.1 Read together with Division 26 - Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 - Electrical.

1.4.2 All VFDs shall be cUL or CSA/UL approved.

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2 PRODUCTS

2.1 DESIGN

- 2.1.1 Manufacturer shall provide passive matrix-type line filters at the input of each VFD, for motors over 15HP, to reduce the total harmonic current level (THID) to less than 5% at the VFD input where the analysis has shown that the incremental effect of the addition of the VFDs would cause the THID to exceed the allowable values per IEEE 519-2014.
- 2.1.2 The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC induction motors. The motor current shall closely approximate a sine wave.
- 2.1.3 The VFD shall be UL listed for a short circuit current rating (SCCR) of 100 kA and labeled with this rating.
- 2.1.4 The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable. VFDs that do not include 5% DC link impedance shall include 5% AC line reactors in the options enclosure.
- 2.1.5 The VFD must be able to produce full torque at low speed to operate direct drive fans.
- 2.1.6 The VFD must be capable of connection and disconnection to motor while the VFD is under load. This switching shall be accomplished without interlocks or damage to the VFD.
- 2.1.7 All VFDs shall contain integral electromagnetic interference (EMI) filters to attenuate radio frequency interference conducted to the AC power line.
- 2.1.8 Provide sine wave output filters on all 460 Volt and 575 Volt VFDs to limit the dV/dt to 1,000 Volts/0.5 micro seconds at the motor terminals where the developed wiring length between the VFD and the motor exceeds 30m (100 ft).
- 2.1.9 Provide incoming, horsepower rated, disconnect switch with an operating mechanism, door interlocked and padlockable in the open position.

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2.1.10 AC line voltage variation, -10 to +10% of nominal with full output

2.1.11 All VFDs shall be plenum rated.

2.2 PROTECTION

2.2.1 Provide the following VFD protection features as a minimum:

2.2.1.1 Line over and under voltage protection.

2.2.1.2 Phase loss and unbalance protection.

2.2.1.3 Short circuit protection for line to line and line to ground faults.

2.2.1.4 Electronic instantaneous overcurrent protection.

2.2.1.5 Current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload.

2.2.1.6 Motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.

2.2.1.7 Internal over temperature protection.

2.2.1.8 Electronic motor stall protection to trip the VFD off should a motor overload or stall occur.

2.2.1.9 VFD shall catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.

2.2.1.10 The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded. The VFD shall include graphing capability for the last 2 alarms to provide additional diagnostic analysis.

2.2.1.11 When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

2.2.1.12 The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 135% of rated torque for up to 0.5 second while starting.

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2.3 ENVIRONMENT

2.3.1 The VFD shall have the following minimum environmental tolerances.

2.3.1.1 Ambient temperature range of 0°C to 45°C (32°F to 113°F). Units located in non-heated areas shall be provided with thermostatically controlled heater weather enclosure.

2.3.1.2 Maximum humidity of 95% non-condensing.

2.3.1.3 Maximum altitude of 1,000m (3,300ft) for rated output.

2.4 PERFORMANCE

2.4.1 The VFD shall have the following performance features as a minimum:

2.4.1.1 Minimum line side displacement power factor of 0.96 at all speeds and loads.

2.4.1.2 Adjustable minimum and maximum motor frequency of 0 to 120 Hz.

2.4.1.3 Separately adjustable acceleration and deceleration ramps from 0.1 to 3,600 seconds with damping and smoothing parameters for (0% to 100% speed).

2.4.1.4 DC Injection Braking.

2.4.1.5 Automatic restart after an inverter fault trip. The VFD shall attempt to restart automatically 5 times with Lock-Out after the fifth attempt if a restart has not occurred.

2.4.1.6 The VFD shall restart the motor at the speed at which it is rotating and then re-accelerate to the speed called for by the speed reference signal.

2.4.1.7 Capable of running without a motor connected for setup and testing.

2.4.1.8 Capable of accepting the opening of a remote motor disconnect while running without causing damage to the VFD.

2.4.1.9 Auto restart after power outage.

2.4.1.10 Skip frequency reject point to prevent the fan/pump from operating

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at a resonant speed. Adjustable centre frequency with a band width of 0 - 10 Hz.

2.4.1.11 Automatic/manual signal follower for 4-20 mA, 0-20mA, 0-10 VDC or 2-10 VDC reference.

2.5 OPERATOR INTERFACE

2.5.1 Provide a door mounted keypad with an Alpha-numeric high resolution display to allow the operations personnel to set up and monitor the VFD parameters, observe output speed, load or other programmable values and monitor status and fault information, complete with tactile keys and backlit display.

2.5.2 The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System

2.5.3 Provide maintenance monitoring to display the time since starting, total elapsed run time and total power consumed in kWh. Also provide maintenance target alarm to alert the operator with a displayed message.

2.5.4 Provide the following control functions on the door mounted keypad:

2.5.4.1 Run (Hand and Auto Mode)

2.5.4.2 Stop (Hand and Auto Mode)

2.5.4.3 Parameterization button (to toggle between parameters)

2.5.5 Provide a selectable display to observe the following parameters:

2.5.5.1 Frequency

2.5.5.2 Motor Current

2.5.5.3 Motor Voltage

2.5.5.4 VFD Output Power

2.5.5.5 VFD Output Energy

2.5.5.6 VFD Temperature

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- 2.5.6 Controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or the feedback signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.
- 2.5.7 The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset. Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
- 2.5.8 A run permissive circuit shall be provided to accept a “system ready” signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output “run request” signal to indicate to the external equipment that the VFD has received a request to run.
- 2.5.9 VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F).
- 2.5.10 VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.
- 2.6 COMMUNICATION AND CONTROL
- 2.6.1 Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
- 2.6.2 Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.
- 2.6.3 Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.
- 2.6.4 Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.

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- 2.6.4.1 Each shall be independently selectable to be used with either an analog voltage or current signal.
- 2.6.4.2 The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.
- 2.6.4.3 A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.
- 2.6.4.4 The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,
- 2.6.5 One programmable analog current output (0 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.
- 2.6.6 It shall be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.
- 2.6.7 Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter's override mode. Fire-mode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.
- 2.6.8 The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:
 - 2.6.8.1 Johnson Controls Metasys N2
 - 2.6.8.2 Modbus RTU
 - 2.6.8.3 Siemens FLN
 - 2.6.8.4 BACnet MS/TP
- 2.6.9 Option boards for the following protocols shall be available:

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- 2.6.9.1 BACnet
- 2.6.9.2 Ethernet
- 2.6.9.3 DeviceNet
- 2.6.9.4 Profibus DP V1
- 2.6.9.5 Profinet SRT
- 2.6.9.6 Modbus TCP
- 2.6.9.7 LonWorks Free Topology (FTP) certified to LonMark standard 3.3
- 2.6.10 VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.
- 2.6.11 The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

2.7 SYSTEM OPERATION

- 2.7.1 If "Manual" mode is selected the VFD/motor shall start when the run key is depressed. The speed shall be controlled by depressing the Accelerate or Decelerate keys on the keypad or by the direct speed set mode.
- 2.7.2 If "Auto" mode is selected the VFD/motor shall start when a contact closure run command is received from the BAS. The speed shall be controlled by a speed reference signal from the BAS.
- 2.7.3 In the event of a power outage the VFD shall automatically restart when the power returns provided the run command is maintained.
- 2.7.4 In the event of an inverter fault trip, the VFD shall attempt to restart automatically up to maximum of five attempts. If, after five attempts, restart does not occur, the VFD shall lock out.

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2.8 WARRANTY

2.8.1 The complete VFD shall be warranted by the manufacturer for a period of 12 months from the date of start-up. The warranty shall be provided by the VFD manufacturer and not a third party. A written warranty statement shall be provided with the submittals.

2.8.2 The manufacturer shall offer an optional, extended warranty allowing the VFD warranty to be extended to up to 6 years.

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Install each VFD in accordance with manufacturer's recommendations and local, provincial and national safety codes.

3.1.2 Use motors with a minimum of class F insulation. Motor shall meet NEMA MG-1 Part 31. Motor shall be rated for inverter duty.

3.1.3 Provide on-site commissioning (start-up) of the VFDs by a factory-authorized technician. Allow a minimum of 1/2 day per system. Also, include an allowance for a second visit to site of one-day duration to train operating personnel in the operation and maintenance of the VFDs.

3.1.4 Upon completion of the installation, the supplier of VFDs shall supply four complete sets of operation and maintenance manuals including wiring and connection diagrams.

3.1.5 Upon completion of the start-up, the supplier of VFDs shall supply four complete sets of typed report and one USB drive with parameters ready for uploading for future use.

END OF SECTION

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Section No.: **20 25 00**
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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Flush and clean all recirculating closed and open systems, and all plumbing systems.

1.2.1.2 Provide chemical treatment equipment, chemicals and test equipment for all heating water, chilled water, steam, and glycol-closed water systems, and for open condenser and cooling tower spray water systems.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for:

1.3.1.1 All chemical treatment equipment, chemicals, and installation details.

1.3.2 Provide operating manuals and testing instructions.

1.3.3 Provide Material Safety Data Sheets for each chemical and testing reagent.

1.3.4 Submit letter from chemical treatment supplier that flushing and chemical treatment system and levels have been carried out in accordance with their recommendations.

2 **PRODUCTS**

2.1 CLOSED LOOP SYSTEMS

2.1.1 Provide and install on each closed water recirculating system, a Norkem Model VTF-2HP by-pass pot feeder rated for 0.126 l/s (2.0 gpm) / 0.315 l/s (5.0 gpm). Feeder shall be of steel construction, and shall have a working pressure of 2,071kPa (300 psi). Provide

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inlet, outlet and drain valves.

- 2.1.2 Provide a sidestream filter. Filter shall be sized to handle five (5) percent of recirculating rate of system. The filter shall be of steel construction and shall be capable of operating at the system working pressure.
- 2.1.3 Provide one (1) box (30) of 20-micron cartridges.
- 2.1.4 Provide a four-station corrosion coupon rack with flow regulator.
- 2.1.5 Provide sufficient Norkem T-333 all-organic type corrosion inhibitor to maintain the systems residual inhibitor level at 80-100 ppm. The inhibitor shall contain a water-soluble amine for pH buffering.
- 2.2 **CLOSED LOOP SYSTEMS WITH ANTIFREEZE PROTECTION**
- 2.2.1 Provide chemical treatment as described under Paragraph 2.1 – Closed Loop Systems.
- 2.2.2 Provide Model MXAGS1000 automatic glycol feed system with 120V / 0.25 kW ($\frac{1}{3}$ HP) gear pump, a 205 liters (45 Imp. gallons) polyethylene tank, 120V / 0.19 kW ($\frac{1}{4}$ HP) mixer, complete with cover, control panel, pressure switch, pressure gauge, relief valve, isolation valves and level switch mounted on stand.
- 2.2.3 Fill heating systems with 25% inhibited propylene glycol equal to Dowtherm SR1 (Dowfrost). Fill condenser/chilled water system with 25% inhibited ethylene (propylene) glycol equal to Dowtherm SR1 (Dowfrost).

3 **EXECUTION**

3.1 **GENERAL**

- 3.1.1 Install bypass piping using Schedule 80 PVC piping.
- 3.1.2 Line side power wiring shall be provided by Division 26 - Electrical. Provide certified wiring schematics for the work of Division 26 - Electrical for associated equipment.
- 3.1.3 Field control wiring of local safeties and interlocks shall be provided under this Section.
- 3.1.4 The water treatment Subcontractor shall make regular visits to the site during the first year's operation (as a minimum once a month). A report containing findings and recommendations shall be

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submitted to the Owner following each visit.

- 3.1.5 Provide Material Safety Data Sheet for each inhibitor and test reagent.
- 3.1.6 Provide the following test equipment in test cabinet Model NK-CAB:
 - 3.1.6.1 1 x conductivity meter Model 512M5 or 512M10 (for steam boilers)
 - 3.1.6.2 1 x pH/TDS pen
 - 3.1.6.3 For closed loop systems: 1 x molybdenum (nitrite / all-organic) test kit TK-600 (TK-700 / TK-500)
 - 3.1.6.4 For cooling towers: 1 x OP test kit TK-500
 - 3.1.6.5 For steam boilers: 1 x hardness test kit TK-100, 1 x sulfite test kit TK-400
 - 3.1.6.6 For glycol systems: 1 x refractometer Model G2009
- 3.2 PRE-OPERATIONAL CLEANING OF CLOSED AND OPEN SYSTEMS
 - 3.2.1 Prior to cleaning, the Contractor shall verify that systems have been hydro-statically tested.
 - 3.2.2 Flush all fluid-carrying systems after completion with a stream of clear water at the highest obtainable pressure and velocity. Discharge the flushing fluid through all strainers and out through line-size valves with hose end. Clean all strainers. Repeat flushing operation to the satisfaction of the Consultant until no foreign matter collects in the strainer. Drain all tanks and clean tanks. Inspect all exchanger piping and clean as necessary.
 - 3.2.3 Drain the test water, refill the system and add the cleaning chemical. Introduce a 1% solution of Norkem T-550 neutral pH cleaner into the system for a minimum of 72 hours. After recirculation, rinse for 24 hours with fresh water, drain, refill and initiate system treatment. Norkem T-550 can be introduced into the system by means of a chemical pump, by-pass feeder or eductor.
 - 3.2.4 Ensure that all valves including control valves are fully open during flushing and boiling out.

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END OF SECTION

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Section No.: **Division 21 - Fire Suppression**
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Approved Equals

Section 21 12 00 Fire Standpipe Systems

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 FIFAProject No.: **2024-0112**
 Section Name: **Fire Protection Approved Equals**
 Date: **August 30, 2024**

Equipment	Base Specification Supplier	Alternate Manufacturers	Further Alternative Manufacturers	Net Cost Difference
Access Doors	<ul style="list-style-type: none"> Acudor 	<ul style="list-style-type: none"> Lehage Zurn Mifab Nailor-Hart Josam SMS 	_____	- \$ _____
Fire Stopping	<ul style="list-style-type: none"> Firebarrier 	<ul style="list-style-type: none"> Hilti Tremco 	_____	- \$ _____
Fire Extinguishers and Fire Hose Cabinets	<ul style="list-style-type: none"> National Fire Equipment 	<ul style="list-style-type: none"> Wilson & Cousins C.F.H 	_____	- \$ _____

END OF SECTION

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Project No.: 2024-0112
Section Name: **Fire Standpipe Systems**
Section No.: **21 12 00**
Date: November 8, 2024

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Mechanical Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Complete fire extinguishers.

1.3 QUALITY ASSURANCE

1.3.1 Materials shall be listed by UL or ULC.

1.3.2 Comply with all codes, including the Ontario Building Code, local authorities, IAO and NFPA regulations.

1.4 SHOP DRAWINGS

1.4.1 Submit shop drawings for all fire standpipe equipment.

2 **PRODUCTS**

2.1 FIRE EXTINGUISHERS

2.1.1 Provide Model ABC-10, 4.5 kg (10 lbs) multi-purpose dry chemical fire extinguisher with 4A60BC rating in all finished areas where shown on plans and as required to meet coverage and maximum travel distance requirements per the Ontario Fire Code. Mount extinguisher in recessed cabinet NFE Model #CTE-300. Cabinet shall be constructed of 1.19mm (18-gauge) baked grey enamel corrosion protected steel tub with 2mm (14-gauge) grey baked enamel steel door and frame with hollow channel reinforcement. The frame section shall be site adjustable for left or right door swing. Door shall be fitted with full panel of 5mm ($\frac{3}{16}$ ") clear glass, full-length semi-concealed piano hinges, and flush stainless steel door latch.

2.1.2 Provide Model ABC-10, 4.5 kg (10 lbs) multi-purpose dry chemical fire extinguisher with 4A60BC rating in the mechanical rooms, electrical room, diesel room, U.P.S., battery room, switchgear room, and transformer vault. Mount extinguisher near the door

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with an approved aluminum wall bracket.

- 2.1.3 Provide 6 liters(1.6 US gallons) class 'K' extinguisher with ULC rating complete with wall bracket for kitchen and areas and BBQs.

3 **EXECUTION**

3.1 CONFORMANCE LETTER

- 3.1.1 Final NFPA certification letter shall be provided before mechanical compliance letter is issued. Certification letter shall contain contractor's contact information, the building permit number, certification statement in regard to NFPA compliance and be stamped by a licensed professional engineer.

END OF SECTION

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 Section Name: Plumbing & Drainage Approved Equals
 Date: August 30, 2024

Equipment	Manufacturer on which the Contract Documents are Based	Acceptable Alternate Manufacturers	Further Alternative Manufacturers	Net Cost Difference
Access Doors	• Acudor	• Lehage • Zurn • Mifab • Nailor-Hart • Josam • SMS	_____	- \$ _____
Fire Stopping	• 3M	• Hilti • Tremco	_____	- \$ _____
Hangers	• Taylor	• Grinnell • Anvil • Myatt	_____	- \$ _____
Cast Iron Fitting Restraints	• Holdrite		_____	- \$ _____
Valve, Pipe and Equipment Identification	• SMS	• MagTool • Seton	_____	- \$ _____
Insulation (glassfiber)	• Knauf	• Manson • Johns Manville	_____	- \$ _____
Insulation (elastomeric closed cell)	• Armaflex	• Imcoa	_____	- \$ _____
Gate & Globe Valves	• Kitz	• Toyo • Crane • Apollo	_____	- \$ _____
Check Valves	• Kitz	• Toyo • Apollo • Moygro • Mueller • Powell	_____	- \$ _____
Silent Check Valves	• Mueller		_____	- \$ _____
Ball Valves	• Kitz	• Toyo • Apollo • MAS	_____	- \$ _____
Butterfly Valves	• Kitz	• Apollo • Center Line • MAS • Victaulic	_____	- \$ _____

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Circuit Balancing Valves	• RWV	• Victaulic • Armstrong • B&G • Watts • Oventrop	_____	- \$ _____
Pressure Reducing Valves (Liquid)	• Watts	• Fisher • Conbraco • Singer • Cla-Val • Clayton • Bermad	_____	- \$ _____
Motor Control Centres, Starters	• Square D	• Siemens • Cutler-Hammer • Klockner-Moeller • Westinghouse	_____	- \$ _____
Electric Pipe Tracing	• Raychem	• Chromalox • Ouellet	_____	- \$ _____
Variable Frequency Drives	• Danfoss	• ABB • Siemens • Emerson	_____	- \$ _____
Vibration Isolation	• Mason	• Vibro-Acoustics • Kinetics	_____	- \$ _____
Flexible Connections, Expansion Joints	• Senior Flexonics	• US Hose • Hyspan • Flextech	_____	- \$ _____
China Basins	• American Standard	• Crane • Kohler	_____	- \$ _____
Stainless Steel Basins, Sinks	• Franke	• Sterling • Kindred (Acorn) • Moen	_____	- \$ _____
Toilets, Urinals	• American Standard	• Crane • Kohler	_____	- \$ _____
Refrigerated Drinking Fountains	• Elkay	• Haws • Cordley	_____	- \$ _____
Basin Faucets	• American Standard	• Kohler • Chicago • Delta • Symmons	_____	- \$ _____

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Equipment	Manufacturer on which the Contract Documents are Based	Acceptable Alternate Manufacturers	Further Alternative Manufacturers	Net Cost Difference
Sink Faucets	• American Standard	• Kohler • Chicago • Delta • Symmons	_____	- \$ _____
Shower Mixing Valves	• Symmons	• Kohler • American Standard • Delta • Powers • Watts	_____	- \$ _____
Flush Valves	• Sloan	• Delta Teck • Zurn • Crane	_____	- \$ _____
Plumbing Brass	• McGuire	• Zurn • Teck • Watts • Chicago	_____	- \$ _____
Fixture Carriers	• Watts	• Mifab • Zurn • J.R. Smith	_____	- \$ _____
Cartridge Filters	• Everpure		_____	- \$ _____
Drainage Products	• J.R.Smith	• Mifab • Zurn • Watts	_____	- \$ _____
Shock Absorbers	• J.R.Smith	• Mifab • Zurn • Watts	_____	- \$ _____
Water Meters	• Neptune	• Kent	_____	- \$ _____
Backflow Preventers	• Watts	• Apollo • Zurn • Febco • Hersey Grinnell	_____	- \$ _____
Emergency Showers	• Guardian	• Bradley • Western	_____	- \$ _____
Domestic Hot Water Heaters (Electric)	• A.O. Smith	• J.W. Wood • Rheem • Caloritech	_____	- \$ _____
Domestic Hot Water Tanks	• A.O. Smith	• Clemmer • DTE • Reco USA	_____	- \$ _____

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Equipment	Manufacturer on which the Contract Documents are Based	Acceptable Alternate Manufacturers	Further Alternative Manufacturers	Net Cost Difference
Thermometers and Gauges	<ul style="list-style-type: none"> • Terice 	<ul style="list-style-type: none"> • Taylor • Winters • Ashcroft 	_____	- \$ _____
Strainers	<ul style="list-style-type: none"> • Armstrong 	<ul style="list-style-type: none"> • Streamflo • Sarco • Gestra • Mueller 	_____	- \$ _____
Pressure Relief Valves	<ul style="list-style-type: none"> • Armstrong 	<ul style="list-style-type: none"> • Bell & Gossett • Watts 	_____	- \$ _____
Vertical In-Line Pumps	<ul style="list-style-type: none"> • Bell & Gossett 	<ul style="list-style-type: none"> • Armstrong Fluid Technology • Taco 	_____	- \$ _____
Base Mounted Pumps	<ul style="list-style-type: none"> • Bell & Gossett 	<ul style="list-style-type: none"> • Grundfoss • Armstrong Fluid Technology • Grundfoss • Taco 	_____	- \$ _____
Integrated Pumping Systems	<ul style="list-style-type: none"> • Bell & Gossett 	<ul style="list-style-type: none"> • Armstrong Fluid Technology • Grundfoss • Taco 	_____	- \$ _____
In-Line Circulators	<ul style="list-style-type: none"> • Bell & Gossett 	<ul style="list-style-type: none"> • Armstrong Fluid Technology • Grundfoss • Taco 	_____	- \$ _____

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Plumbing Valves**
Section No.: **22 05 23**
Date: November 8, 2024

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Section Name: **Plumbing Valves**
Section No.: **22 05 23**
Date: November 8, 2024

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit Shop Drawings for:

1.2.1.1 All plumbing valves.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All valves shall be of one manufacture unless stated otherwise and should have the manufacturer's name and pressure ratings clearly marked on body. Valves to conform to the current of ANSI, ASTM, ASME standards, and to the applicable MSS.

2.1.2 Bronze valves up to and including 1034kPa (150 psi) steam pressure to be manufactured to ASTM B62-93 standard. Bronze valves up to 1379kPa (200 psi) and 2068kPa (300 psi) steam pressure to be manufactured to ASTM B61-93 standard. Bronze valves used in water systems may be cast bronze to ASTM B584-87 alloy CDA-836.

2.1.3 Iron body valves shall be ductile iron manufactured to ASTM A536-84 Grade 65-45-12 or cast iron ASTM A126-95 Class B standard where ductile iron is not available.

2.1.4 All valves shall have a CRN registration number.

2.1.5 Valve Materials

2.1.5.1 Bronze: to ASTM B62 or B61 as applicable

2.1.5.2 Brass: to ASTM B283 C3770

2.1.5.3 Cast Iron: to ASTM A126, Class B

2.1.5.4 Forge Steel: to ASTM A105N

2.1.5.5 Cast Steel: to ASTM A216WCB

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2.1.6 Valve Markings

2.1.6.1 All pressure ratings, manufacturers' trademark and size to conform as per MSS-SP-25.

2.1.7 End Connections

2.1.7.1 Threaded ends: to ASME B1.20.1

2.1.7.2 Solder ends: to ASME B16.18

2.1.7.3 Flanged ends: to ASME B16.1 (Class 125)

2.1.7.4 Face To Face dimensions: to ASME B16.10

2.1.7.5 Fanged ends: to ASME B16.5

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2.1.8 Testing & Design

2.1.8.1 MSS-SP-80 - Bronze, Gate & Check Valves

2.1.8.2 MSS-SP-110 - Ball Valves

2.1.8.3 MSS –SP-70, 85, 71 - Cast Iron Gate, Globe & Check Valve

2.1.8.4 MSS-SP-72 - American Valve

2.1.8.5 MSS-SP-67 - Kitz, Apollo, Toyo, Demco & WKM E, Butterfly Valves

2.1.8.6 API 602 - Forge Steel Valves (Design)

2.1.8.7 API 598 - Cast Steel Valves, Forge Steel Valves (Testing)

2.1.8.8 API 609 - WKM High Performance BFV

2.1.8.9 API 600 - Cast Steel Valves (Design)

2.2 VALVES FOR LOW PRESSURE SERVICE

2.2.1 This section applies to valves used in domestic cold water, domestic hot water and natural gas systems up to 1,034 kPa (150 psi) system operating pressure.

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2.2.2 Gate Valves

2.2.2.1 50mm (2") dia. or less - shall be Class 125, all bronze, with solid wedge disc, non-rising stem, lead-free (NSF-61).

Threaded ends - Kitz 827
 - Toyo 206A-LF
 - Crane LF-438
 - Apollo 102TLF

Soldered ends - Kitz 828
 - Toyo 207A-LF
 - Crane LF-1320
 - Apollo 102SLF

2.2.3 Globe Valves

2.2.3.1 50mm (2") dia. or less - shall be Class 125, all bronze, with rising stem, fitted with PTFE disc, lead-free (NSF-61).

Threaded ends - Kitz 811
 - Toyo 211A-LF
 - Apollo 120TLF

Soldered ends - Kitz 812
 - Toyo 212A-LF
 - Apollo 120SLF

2.2.4 Butterfly Valves

2.2.4.1 65mm (2-½") dia. and over - shall be Class 125, ductile iron full lug body with aluminum bronze or stainless steel disk, stainless steel stems, EPDM resilient seat, lead-free (NSF-372), with a 1379kPa (200 psi) single flange shut off rating (dead end service) and 121°C (250°F) temperature rating.

2.2.4.2 Valves 65mm (2-½") dia. and up to 100mm (4") dia. shall have a 10-position lever. Valves 150mm (6") dia. and above shall have hand wheel gear activator.

Lug Style - Kitz 6122EL/G
 - MAS D-Series LD4AELH/G
 - Center Line 200XXBG064052/5
 - Apollo LD141-XX-SE1-X

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Grooved ends - Victaulic Series 608N (for copper piping)
 - Victaulic Series 861 Vic-300 (for SS piping)

2.2.5 Check Valves

2.2.5.1 50mm (2") dia. or less - shall be Class 125, brass or copper alloy body, brass disc, PTFE gasket, lead-free (NSF-61), Y pattern swing check.

Threaded ends - Kitz 822
 - Toyo 236A-LF
 - Apollo 163TLF

Soldered ends - Kitz 823
 - Toyo 237A-LF
 - Apollo 163SLF

2.2.5.2 65mm (2-½") dia. and over - shall be Class 150, stainless steel body and trim, PTFE or fluoroelastomer gaskets.

Flanged ends - Kitz 150UOAM

Grooved ends - Victaulic Series 816

2.2.5.3 Wafer Check Valves – stainless steel body, shaft, disc and spring.

Single Flap - Moygro W15A-666

Double Door - Mueller 72-HHH-H-H
 - Powell 3070YMO

2.2.5.4 Silent Check Valves – carbon steel or stainless steel body, stainless steel trim, spring loaded center guided disc, stainless steel spring and shaft.

Flanged ends - Mueller 101MHT (wafer)
 - Mueller 105MHT (globe style)

2.2.6 Ball Valves

2.2.6.1 100mm (4") dia. or less - shall be rated for 1034kPa (150 psi) steam, 4137kPa (600 psi) non-shock cold water or oil, with full or standard port brass or bronze body, lead-free (NSF-61) brass or stainless steel ball, PTFE seats and packing.

Threaded ends - Kitz 858
 - Toyo 5044A-LF

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- Apollo 70LF-100 series
- MAS B-3LF

- Soldered ends
- Kitz 859
 - Toyo 5049A-LF
 - Apollo 70LF-200 series
 - MAS B-4LF

Note: Ball valves may be used in lieu of gate or globe valves for pipe sizes of 100mm (4") dia. or less.

2.2.6.2 Gas ball valves:

2.2.6.2.1 50mm (2") dia. or less - shall be rated for 1034kPa (150 psi) steam, 4137kPa (600 psi) non-shock cold water or oil, with full or standard port brass or bronze body, brass chrome plated ball, Teflon seats and packing, lever handle, CSA approved (CGA 3.16).

- Threaded
- Toyo 5044A
 - Kitz 58
 - MAS B3

2.2.6.2.2 65mm (2-½") dia. and over - shall be Class 150, carbon steel body, stainless steel ball and stem, Teflon packing and gaskets, locking lever and/or gear.

- Flanged
- Kitz 150 SCTAM (1 piece)
 - Kitz 150 SCTBZM (2 piece, full port)

2.2.7 Plug Valves

2.2.7.1 DN80 (3") dia. or less - shall be bronze eccentric plug valve, 1,379kPa (200 psi) non-shock cold water or oil, with memory stop and drip cap, grooved, flanged or screwed ends, as appropriate for piping system.

- DeZurik PEC Series

2.2.7.2 DN100 (4") dia. up to DN300 (12") dia. - shall be bronze eccentric plug valve, 1,379kPa (200 psi) non-shock cold water or oil, with handwheel gear, and grooved, flanged or screwed ends, as appropriate for piping system.

- DeZurik PEC Series

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2.3 VALVES FOR MEDIUM TO HIGH PRESSURE SERVICE

2.3.1 This section applies to valves used in domestic cold water and domestic hot water systems up to 3,440 kPa (500 psi) system operating pressure.

2.3.2 Gate Valves

2.3.2.1 50mm (2") dia. or less - shall be Class 300, stainless steel body and trim, OS&Y, PTFE packing and gasket.

Threaded ends - Kitz AK300UMM

2.3.2.2 65mm (2-½") dia. and over - shall be Class 300, stainless steel body and trim, OS&Y, PTFE packing and gasket.

Flanged ends - Kitz 300UMHAM

2.3.3 Globe Valves

2.3.3.1 50mm (2") dia. or less - shall be Class 300, stainless steel body and trim, OS&Y, PTFE packing and gasket.

Threaded ends - Kitz AK300UPM

2.3.3.2 65mm (2-½") dia. and over - shall be Class 300, stainless steel body and trim, OS&Y, PTFE packing and gasket.

Flanged ends - Kitz 300UPAM

2.3.4 Butterfly Valves (up to 1,724 kPa / 250 psi operating pressure)

2.3.4.1 65mm (2-½") dia. and over - shall be Class 150, cast brass or stainless steel body with aluminum bronze or stainless steel disk, stainless steel stems, Teflon seat, lead-free (NSF-372), with a 2,068 kPa (300 psi) single flange shut off rating (dead end service) and 121°C (250°F) temperature rating.

2.3.4.2 Valves 65mm (2-½") dia. and up to 100mm (4") dia. shall have a 10-position lever. Valves 150mm (6") dia. and above shall have hand wheel gear activator.

Grooved ends - Victaulic Series 608N (for copper piping)
- Victaulic Series 861 Vic-300 (for SS piping)

2.3.5 Check Valves

2.3.5.1 50mm (2") dia. or less - shall be Class 300, stainless steel body,

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PTFE or fluoroelastomer gasket, swing type check.

Threaded ends - Kitz AK300UOM

Grooved ends - Victaulic Series 816

2.3.5.2 65mm (2-½") dia. and over - shall be Class 300, stainless steel body and bolted cover, PTFE gasket, swing type check.

Flanged ends - Kitz 300UOAM

2.3.5.3 Wafer Check Valves – stainless steel body, shaft, disc and spring.

Single Flap - Moygro W30A-666

Double Door - Mueller 74-HHH-H-H
- Powell 3070YMO

2.3.5.4 Silent Check Valves – carbon steel or stainless steel body, stainless steel trim, spring loaded center guided disc, stainless steel spring and shaft.

Flanged ends - Mueller 103MHT (wafer)
- Mueller 109MHT (globe style)

2.3.6 Ball Valves

2.3.6.1 100mm (4") dia. or less - shall be rated for 1034kPa (150 psi) steam, 4137kPa (600 psi) non-shock cold water or oil, with full or standard port brass or bronze body, lead-free (NSF-61) brass or stainless steel ball, PTFE seats and packing.

Threaded ends - Kitz 858
- Toyo 5044A-LF
- Apollo 70LF-100 series
- MAS B-3LF

Soldered ends - Kitz 859
- Toyo 5049A-LF
- Apollo 70LF-200 series
- MAS B-4LF

Note: Ball valves may be used in lieu of gate or globe valves for pipe sizes of 100mm (4") dia. or less.

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3 EXECUTION

3.1 GENERAL

- 3.1.1 Valves shall be the same size as the line in which installed.
- 3.1.2 Valves shall be located in such a manner that the top works, operators, and bonnets may be easily removed.
- 3.1.3 Seats and seals used in potable water systems shall be ANSI classified in accordance with NSF-61.
- 3.1.4 Stems of valves shall be positioned for maximum ease in use, but in no event in a manner causing a hazard, nor with stem down unless specifically shown as such.
- 3.1.5 Provide valves where shown on the Drawings, or on schematic diagrams, or in details, or as specified in the Contract Documents.
- 3.1.6 Provide drain valves at all low points. Drain valves shall be ball or gate valves, complete with cap and chain.

3.2 GATE VALVES

- 3.2.1 Provide gate valves:
 - 3.2.1.1 Where indicated on the Drawings and in the Specification.
 - 3.2.1.2 On all branch lines.
 - 3.2.1.3 As isolation of each floor for all services.
 - 3.2.1.4 At the base of all risers.

3.3 GLOBE OR ECCENTRIC PLUG VALVES

- 3.3.1 Provide globe and/or eccentric plug valves:
 - 3.3.1.1 Where indicated on the Drawings and in the Specification.
 - 3.3.1.2 On all bypass systems.
 - 3.3.1.3 Where required for throttling control.
- 3.3.2 For balancing of domestic hot water recirculation system, provide thermostatic flow regulators in lieu of throttling valves. Refer to Section 22 11 19 – Domestic Water Piping Specialties.

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3.4 BUTTERFLY VALVES

3.4.1 Provide butterfly valves:

3.4.1.1 Where indicated on Drawings and in the Specification.

3.4.2 For pipe sizes DN65 (2-½") and larger, butterfly valves may be used in lieu of gate valves.

3.5 CHECK VALVES

3.5.1 Provide check valves:

3.5.1.1 Where indicated on the Drawings and in the Specification.

3.5.1.2 On the discharge of all pumps.

3.5.1.3 On the discharge of multiple equipment.

3.6 BALL VALVES

3.6.1 Install ball valves in the following locations:

3.6.1.1 Where indicated on the Drawings and in the Specification.

3.6.1.2 At each single plumbing fixture.

3.6.1.3 At each single item of equipment.

3.6.2 For pipe sizes DN100 (4") and smaller, ball valves may be used in lieu of gate and globe valves.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide an electrical pipe tracing system as indicated on the Drawings and specified in this Section.

1.2.2 Connect heat trace power supply from disconnect switches provided by Division 26 - Electrical. Refer to Division 26 – Electrical drawings for exact locations. Co-ordinate power requirements with Division 26 – Electrical. Refer to Section 20 05 14 – Electrical Wiring for wiring requirements.

1.2.3 Provide electric tracing for the following services:

1.2.3.1 All domestic water piping (cold, hot, hot recirculation), including humidification make-up, in unheated areas or outside the building.

1.2.3.2 All sanitary and storm drain lines in unheated areas except parking drain sanitary system.

1.2.3.3 Humidifier drain lines, exposed on roof.

1.2.3.4 Trench drains exposed to freezing.

1.2.3.5 Roof gutters.

1.3 SHOP DRAWINGS

1.3.1 Provide shop drawings for:

- heat trace cables
- power connection, splice and tee kits
- temperature sensors, moisture sensors, control panel, and contactor modules
- accessories including tape, straps, banding, labels

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1.4 ELECTRICAL EQUIPMENT AND WORK

1.4.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 – Electrical.

1.4.2 The entire design and installation shall comply with the Ontario Electrical Safety Code and all applicable regulations. Heating cable circuits shall be protected by a ground-fault device for equipment protection. This requirement is in accordance with section 427-22 of the NEC-1996. Ground-fault protection is included with the control system specified for all applications.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Furnish and install a complete cUL Listed, CSA Certified, or FM approved system of heating cables, components, and controls to provide freeze protection of piping as indicated in the Contract Documents.

2.2 PIPE FREEZE PROTECTION CABLES

2.2.1 The self-regulating heating cable shall consist of two (2) 16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field. The heating cable shall be covered by a radiation-crosslinked, modified polyolefin dielectric jacket. To provide a ground path and to enhance the heating cable's ruggedness, the heating cable shall have a braid of tinned copper and an outer jacket of modified polyolefin (-CR), as required per section 427-23 of the NEC-1996. For installation on plastic piping, the heating cable shall be applied using aluminum tape (AT-180). The heating cable shall be Tyco Thermal Controls, XL-Trace series, or approved equivalent.

2.2.2 In order to conserve energy and to prevent overheating, the heating cable shall have a self-regulating factor of at least 90 %. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 4.4°C (40°F) pipe temperature operation to 65.6°C (150°F) pipe temperature operation.

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2.2.3 The heating cable shall operate on line voltage of 120 Volts without the use of transformers.

2.2.4 The heating cable for metal-pipe freeze protection shall be sized according to the table below. The required heating cable output rating is in Watts per meter (foot) at 10°C (50°F). (Heating cable selection is based on 51mm (2 inch) fiberglass insulation on metal piping.)

Pipe size mm (inches)	Minimum Ambient Temperature	
	-17.8°C (0°F)	-28.9°C (-20°F)
100 (4") or less	16.4 (5) Watts	16.4 (5) Watts
150 (6")	16.4 (5) Watts	26.2 (8) Watts
200 (8")	16.4 (5) Watts	26.2 (8) Watts
250 (10") or more	16.4 (5) Watts	2 strips of 16.4 (5) Watts

2.2.5 Power connection, end seal, splice, and tee kit components shall be cUL Listed, CSA Certified, or FM Approved for use as part of the system to provide pipe freeze protection. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. Installation shall not require the installing Subcontractor to cut into the heating-cable core to expose the bus wires. All components that make an electrical connection shall be re-enterable for servicing. Installation of power-connection kits shall be under Division 22 - Plumbing.

2.2.6 No component shall use silicone to seal the electrical connections. An exception will be made in areas where a conduit transition is required.

2.3 TRENCH DRAIN DE-ICING CABLES

2.3.1 Heating cables for trench drain de-icing shall be approved as snow-melting and de-icing equipment to applicable Canadian standards.

2.3.2 The heating cable shall be Pyrotenax brand, type MI series heating cable manufactured by Tyco Thermal Controls, or approved

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equivalent. The heating element shall be magnesium-oxide insulated, with a resistance-alloy conductor and seamless Alloy 825-sheath. No combustible materials shall be allowed between the heating element and sheath. All heating cable materials shall be inorganic to resist corrosion. Cables shall be designed for heat output not exceeding 16.4 W/m (5 W/ft).

2.3.3 This Subcontractor is responsible for field-measurement of trench drain segment lengths to confirm tender design suitability.

2.4 GUTTER DE-ICING CABLES

2.4.1 Heating cables for canopy gutters shall be approved and listed as snow-melting and de-icing equipment to applicable Canadian standards.

2.4.2 Gutter de-icing cables shall be Raychem IceStop self-regulating heating cable manufactured by Tyco Thermal Controls, model GM-2XT or approved equivalent. It shall consist of a continuous conductive-polymer core, radiation-crosslinked, between two 16AWG nickel-plated copper bus wires.

2.4.3 Gutter de-icing cables shall vary their heat output according to temperature, such that heat output in ice or snow at 32°F (0°C) is no less than 12 W/ft when operating at 208V.

2.4.4 Gutter de-icing cables shall have a Fluoropolymer jacket for improved resistance to UV, organic chemical exposure, and abrasion.

2.4.5 Power connection, end seal, splice, and tee kit components shall be cUL Listed, CSA Certified, or FM Approved for use as part of the de-icing system. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. Installation shall not require the Installing Contractor to cut into the heating-cable core to expose the bus wires. All components that make an electrical connection shall be re-enterable for servicing. Tyco Thermal Controls RayClic series or approved equivalent. Installation of power-connection kits shall be under Division 22 - Plumbing. All fasteners shall be provided by the heating cable manufacturer.

2.5 TEMPERATURE AND MOISTURE SENSORS

2.5.1 Drainage piping shall have one sensor per "zone", mounted to the ceiling in unheated space and shall operate on Proportional Ambient Sensing Control. Trench Drain and Canopy Gutter De-

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Icing cables shall be energized upon the detection of precipitation at low temperatures, and remain energized until runoff is clear.

2.5.2 Temperature sensors shall be 100-ohm platinum RTD (Resistance Temperature Devices), with 3m tails mechanically protected by a corrugated steel sheath and ½" gland fitting for connection to the junction box. Digit race RTD10CS or approved equivalent. Temperature sensors shall be connected to the control system terminals as indicated on heat-tracing schedules. Coordinate conduit and low-voltage signal wiring with Division 26 - Electrical. RTD wiring shall be shielded 3-conductor, 22AWG + drain, Belden type 8771 or approved equivalent.

2.5.3 Aerial Snow-Sensors shall detect precipitation occurring below 38°F (4°C) and close an internal contact to send a demand signal to the control system. Snow Sensors shall operate at 120V. Digit race LCD-7A or approved equivalent.

2.5.4 Gutter Moisture Sensors shall be mounted horizontally in the gutter as indicated on construction drawings, and shall detect the presence of moisture (i.e. runoff water) below 38°F (4°C) to send a demand signal to the control system. The intent of this device is to hold associated circuits on until all melt water is clear of the drainage system. Digit race type GIT-3A or approved equivalent. This Subcontractor is responsible for providing auxiliary relays to prevent line voltage reaching low-voltage control terminals.

2.6 CONTROL SYSTEM

2.6.1 DDC Control System

2.6.1.1 All sensors shall communicate with a DDC system, Digit race ACCS-30 or approved equivalent. This approach serves to minimize the number of sensing devices required for efficient system operation and also to eliminate field-location of control devices and thus reduce the risk of tampering.

2.6.1.2 The Heating Cable manufacturer shall provide a DDC system with pre-programmed parameters to concurrently control and monitor heating cable circuits fire-protection pipe freeze protection. All system programming shall be through a CSA-listed central User Interface Terminal, Tyco Thermal Controls type ACCS-UIT2 or approved equivalent.

2.6.1.3 Heating Cable circuits and sensor signals (refer to Subsection 2.5 above) shall be connected to cUL-listed remote Power Control

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Modules, Tyco Thermal Controls type ACCS-PCM2-5 or approved equivalent. The Power Control Modules shall each house five two-pole contactors rated to 30A/277V, and five sensor inputs. Power Control Modules shall also include ground-fault sensing devices for each heating cable circuit, the status of which shall be monitored by the control system.

- 2.6.1.4 Power Control Modules and User Interface Terminal shall be interconnected using RS-485 communication series. Coordinate communication conduit requirements with Division 26 - Electrical.
- 2.6.1.5 The Control System shall be capable of communicating ground fault, temperature alarms, and status alarms through programmable alarm contacts. Coordinate with Division 26 - Electrical.
- 2.6.1.6 The Control System shall be capable of communicating operating status, power consumption, and alarms to the Building Automation System in BACnet protocol.
- 2.6.2 No heat tracing circuit shall extend more than 600mm (24") beyond a point where such junctions permit optional flow paths. In such cases, separately controlled tracers shall be used.
- 2.6.3 Separately controlled heating circuits shall be provided on dead end legs and closed bypasses.
- 2.6.4 Where the rating of the thermostat would be exceeded, it shall be used in conjunction with a relay or contactor.

3 **EXECUTION**

3.1 PIPE FREEZE PROTECTION

- 3.1.1 Hydrostatically test all piping prior to installation of tracing cables.
- 3.1.2 Heating Cable Installation shall comply with manufacturer's recommendations.
- 3.1.3 The cable shall be fastened to metallic piping at intervals no more than 300mm (12") using heat-resistant fiberglass tape, type GT-66 or approved equivalent. Metallic tie-wraps shall not be acceptable as they may puncture the heating cable jacket. When installing on polymer-based piping, aluminum heat-transfer tape shall be installed along the entire length of heating cable to improve performance.

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- 3.1.4 Extra cable shall be used at points such as valves and flanges to compensate for increased heat loss.
- 3.1.5 All terminations shall be protected from the weather and from physical damage.
- 3.1.6 Any field alternations or deviations shall proceed only after authority via signed change order has been issued by the Consultant. All changes shall be accurately recorded by the Contractor and shall be turned over to the Consultant upon completion of the work.
- 3.1.7 Junction boxes, thermostats, and the like shall not be attached to the insulation, but shall be mounted on brackets fabricated of galvanized angle, channel or other material of sufficient strength to support equipment mounted on them.
- 3.1.8 Apply "Electric Traced" labels to the outside of the thermal insulation, on alternating sides at 3m intervals.
- 3.2 **TRENCH DRAIN DE-ICING**
- 3.2.1 Trench Drain installation should be complete prior to heating cable installation so as to reduce the risk of damage.
- 3.2.2 Heating Cables shall be connected to power at ceiling-mounted junction boxes as indicated in the Contract Documents. Trench Drain cable cold-leads shall enter Trench drain piping through appropriate pipe fittings. No heating cable shall be located in the air. This Subcontractor is responsible for ensuring that cold leads are long enough to reach from drain pipe fittings to junction box.
- 3.2.3 Heating Cables shall be laid along the entirety of the base of the trench and fastened at no less than 5m intervals to clips (e.g. Tyco Thermal Controls type GMK-RC) adhered to the trench drain walls. No penetrations shall be made to the Trench itself. Adhesives shall be suitable for attaching metal clips to trench drain material; coordinate with Trench Drain supplier.

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3.3 GUTTER DE-ICING

- 3.3.1 Canopy gutter construction shall be completed prior to installation of de-icing cables.
- 3.3.2 Comply with manufacturer's installation recommendations.
- 3.3.3 Gutters wider than 150mm (6") require two runs of heating cables. Heating cables shall be fastened using a pair of heating cable clips (eg type GMK-RC) every 3m (10ft).
- 3.3.4 Drains shall be traced to 1m (3ft) inside heated space using a loop of heating cable to maintain a continuous circuit. Protect the cable from rough edges at drain entry using a hanger bracket (eg type GM-RAKE).
- 3.3.5 Power Connection, splice and tee kits shall be mounted outside of the gutter itself. Wall- or pipe-mount brackets may be provided with power connections.

3.4 SENSORS

- 3.4.1 Install all sensing devices in accordance with manufacturer's recommendations. Refer to notes in Subsection 2.5 above.
- 3.4.2 Temperature sensors installed on piping (for Line-Sensing) shall be located opposite the heating cable so as to sense the coldest temperature on the segment of pipe.
- 3.4.3 Temperature sensors installed in air (for Ambient-Sensing) shall be strapped to the ceiling in a location such that the temperature is representative of the exposure temperature of any associated heat-tracing. Ambient temperature sensors shall not be installed adjacent to exhaust vents.
- 3.4.4 Aerial Snow-Sensors shall be installed in a location such that they are exposed to precipitation from all directions and not subject to heating or exhaust vents. They shall be wired such that line voltage is not introduced to the signal run.
- 3.4.5 Gutter Snow-Sensors shall be installed between runs of heating cable with sensor grid pointed "upstream", i.e. toward the flow of melt-water. They shall be wired such that line voltage is not introduced to the signal run.

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3.5 CONTROL SYSTEM

- 3.5.1 Install all control components in accordance with manufacturer's recommendations.
- 3.5.2 Sensor signal wiring shall be connected to the appropriate terminal within the appropriate power control module.
- 3.5.3 Control system components shall all be connected in series, using RS-485 twisted pair communication wiring. Coordinate necessary communication conduit runs with Division 26 – Electrical Subcontractor.

3.6 TESTING, COMMISSIONING AND REPORTING

- 3.6.1 All Self-Regulating Cables (for pipe tracing and gutter tracing) shall be tested for insulation resistance using a megohmmeter at 500, 1000, and 2500VDC and results shall exceed 1000MΩ to be acceptable. Self-Regulating cables shall also be tested for capacitance to verify continuous circuit lengths, with results recorded in nF and in approximate corresponding length. Refer to manufacturer's installation guides for nF/ft conversion rates for each type of cable.
- 3.6.2 All Mineral-Insulated Cables (for trench drain de-icing) shall be tested for insulation resistance using a megohmmeter at 500VDC and results shall consistently exceed 100 MΩ to be acceptable. Cables shall also be tested for continuity, with results recorded in resistance (Ω) and approximate corresponding length.
- 3.6.3 Sensors and Control System shall be concurrently tested and commissioned with the assistance of the manufacturer. Temperature sensors may be tested by observing readings and comparing with actual temperature. Moisture sensors shall be tested by simulating activation criteria (low temperature and moisture) and observing contact engagement.
- 3.6.4 The Division 22 - Plumbing Subcontractor is responsible for carrying testing, programming and commissioning costs as part of this Contract.

END OF SECTION

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3.1	Motor Starters

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Section Name: **Motor Starters and MCCs**
Section No.: **22 05 36**
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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All motor starters for mechanical equipment.

1.2.1.2 All motor control centres for mechanical equipment.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for:

1.3.1.1 All motor starters.

1.3.1.2 All motor control centres.

1.4 ELECTRICAL EQUIPMENT AND WORK

1.4.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 – Electrical.

2 **PRODUCTS**

2.1 MOTOR STARTERS

2.1.1 Provide where indicated, shown the Motor Starter Schedules and as specified in this Section separate motor starters not forming part of a motor control centre for all mechanical equipment (except those equipped with packaged starters).

2.1.2 Motor starters shall be supplied by the manufacturer of the motor control centres specified, and shall meet the requirements therein complete with disconnect switch, fuses, control transformer, and all auxiliary devices.

2.1.3 Provide combination type with non-fused disconnect switch for individual motor starters equal to CGE CR 208, where overcurrent

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protection has been provided at motor control centre or distribution source.

- 2.1.4 Provide combination type with fusible disconnect switches equal to CGE CR 208 for grouped motor starters supplied from a common feeder or splitter. Include all interconnection power wiring.
- 2.1.5 Manual starters for single phase fractional horsepower motors unless otherwise indicated shall be equal to CGE CR 1061 with pilot light in cover. In finished areas, provide flush mounted units with stainless steel covers and pilot lights.
- 2.1.6 Where starters are grouped, provide a common backboard, interlocking and control wiring indicated on the Motor Control Schedules and engraved nameplates indicating source of control supply if separate from the starter.

3 **EXECUTION**

3.1 MOTOR STARTERS

- 3.1.1 Provide lamacoid plastic plates identifying all starters. Provide warning label for motors under remote control. Adhere to Section 20 05 53 – Identification colour scheme for tags.

END OF SECTION

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3.1	Cleanouts and Cleanout Access Covers

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings for the following equipment:

1.2.1.1 Cleanouts

2 **PRODUCTS**

2.1 CLEANOUTS AND CLEANOUT ACCESS COVERS

2.1.1 Provide cleanouts where shown on Contract Drawings on all drainage and waste systems, and as required by the Local Plumbing Code, including the following:

2.1.1.1 Where there is a change of direction of 45 degrees or more.

2.1.1.2 Not more than 15m (50'-0") apart on straight runs for DN100 (4") and less; 30m (100'-0") for DN150 (6") and greater.

2.1.1.3 On sanitary drain stacks serving kitchen sinks, at every second floor.

2.1.1.4 At the base of every stack and rainwater leader.

2.1.1.5 Where drains leave the building.

2.1.1.6 On footing drains where shown on the Drawings.

2.1.2 Bring cleanouts below floor up to finished floor with a 'Y' and 1/8th bend. Locate all cleanouts for easy access and in areas of least traffic, as directed by Consultant.

2.1.3 Make cleanouts full size of drain up to and including 100mm (4") drains. For drains larger than 100mm (4"), use 100mm (4") cleanouts.

2.1.4 Cleanouts in floor – cast iron body, removable positive gasket seal closure, 127mmx127mm (5"x5") adjustable square cover. J.R.Smith Series 4000; Zurn ZN1400 Series; Mifab C1100 Series, Watts CO-200-S.

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- 2.1.4.1 Finished areas with nickel bronze top. Watts CO-200-S-1 or equivalent.
- 2.1.4.2 Tiled areas with nickel bronze top. Watts CO-200-TS or equivalent.
- 2.1.4.3 Terrazzo areas with nickel bronze top. Watts CO-200-US or equivalent.
- 2.1.4.4 Concrete areas with extra heavy cast iron top. Watts CO-200-SX-4 or equivalent.
- 2.1.5 Cleanouts in walls.
 - 2.1.5.1 Face-of-wall access cover for openings in tile, masonry and plaster walls with round C.P. bronze frame and secured cover. J.R.Smith 4720, Watts CO-300 Series.
 - 2.1.5.2 Flush-with-wall access cover for plaster and wet wall constructions with round C.P. bronze frame and secured cover. J.R.Smith 4725; Zurn Z1463; Mifab C1440-R6, Watts CO-300 Series.
 - 2.1.5.3 Access doors in tile, masonry and plaster walls, and in acoustic tile: refer to Section 15050 – Basic Materials and Methods.
 - 2.1.5.4 Urinal cleanout – wall access cleanout with bronze plug, S.S. bolt and wingnut, and 100mm (4") polished S.S. secured cover. J.R.Smith SQ4-1819; Zurn Z1666-1; Mifab C1440-RD-3, Watts WUCO.
- 2.1.6 Cleanouts at the base of each stack and rainwater leader – cast iron cleanout tee and countersunk iron plug with gasket seal, less cover. J.R.Smith 4510; Zurn Z1445-HBXSP; Mifab C1460, Watts CO-460.
- 2.1.7 Cleanouts for concealed cast iron stacks – cast iron cleanout tee and countersunk iron plug with gasket seal, S.S. round cover and screw. J.R.Smith 4530; Zurn Z1446-HBXSP; Mifab C1460-RD-3, Watts CO-460-RD.
- 2.1.8 Cleanouts for exposed and concealed copper stacks to be by pipe manufacturer.

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3 EXECUTION

3.1 CLEANOUTS AND CLEANOUT ACCESS COVERS

- 3.1.1 Cleanouts on drains outside building shall be brought up to grade with a DN100 (4") 'Y' and 1/8th bend in medium weight soil pipe with solid brass recess plug-in top. Provide necessary support for soil pipe and set cleanout flush with grade in a 300mm by 300mm by 150mm (12" x 12" x 6") concrete pad.
- 3.1.2 In all areas with seamless flooring and plastic terrazzo finishes provide special flanges. These flanges shall be 100mm (4") larger in diameter than the drain or cleanout top of sleeve diameter, and located approximately 5mm ($\frac{3}{16}$ ") below the top flanges to be of the same material as the drain or cleanout finish.
- 3.1.3 Provide special flanges for cleanouts as described above.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Domestic cold water piping, including connections to all fixtures and equipment, capped connections, and connections to municipal water supply.

1.2.1.2 Domestic hot water piping, including connections to all fixtures and equipment and capped connections.

1.3 REGULATORY REQUIREMENTS

1.3.1 Standards listed by reference, including revisions by issuing authority, form part of this Specification Section to extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title, or other designation established by issuing authority. Standards subsequently referenced in this Section are referred to by issuing authority abbreviation and standard designation.

1.3.2 In addition to specific requirements for pipe fittings as further specified in this document and where applicable, the equipment shall comply with the Boiler and Pressure Vessels Act (the "Act") and CSA Standard B51.

1.3.3 In compliance with the Act and relevant Codes, all fittings shall be registered by the manufacturer, and shall be identified by the appropriate Canadian registration number.

1.3.4 Where fittings are provided without the appropriate Canadian registration number, the Contractor shall obtain a copy of the manufacturer's Statutory Declaration as provided to the authorities having jurisdiction.

1.3.5 All welding and fabrication shall be to the requirements of the ANSI/ASME B31.9 code for pressure piping and CSA standard B51 code for the Construction and Inspection of Boilers and

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Pressure Vessels.

- 1.3.6 All copper piping shall be certified to ASTM Standard B42 for Seamless Copper Pipe or ASTM Standard B88 for Seamless Copper Water Tube.
- 1.3.7 All stainless steel piping shall be certified to ASNI/AWWA C220-98, ASME B16.9 for fittings and ASTM A269 for tubing.
 - 1.3.7.1 Systems for Pressure Applications.
 - 1.3.7.2 CAN/ULC-S101-M89 Standard Methods of Fire Endurance Tests of Building Construction and Materials.
 - 1.3.7.3 CAN/ULC-S115-M95 Standard Method of Fire Tests of Firestop Systems.
 - 1.3.7.4 CAN/ULC-S102.2-M88 Standard for Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials and Assemblies.
- 1.3.8 Plastic Pipes Institute (PPI):
 - 1.3.8.1 PPI Technical Report TR-4/00.
 - 1.3.9 Wirsbo, AQUAPEX *Installation Handbook*, current edition.
- 1.4 **SUBMITTALS**
 - 1.4.1 Provide shop drawings for all specified Products, including:
 - 1.4.1.1 Piping material and fittings.
 - 1.4.1.2 Joining material (flux, solder, filler metal, coupling)
 - 1.4.1.3 Submit verification of Standard Grade hydrostatic pressure ratings from Plastic Pipe Institute in accordance with TR-4/00. The following three (3) standard grade ratings are required: 93°C (200°F) at 551 kPa (80 psi); 82°C (180°F) at 689 kPa (100 psi) and 23°C (73.4°F) at 1,102 kPa (160 psi).
 - 1.4.1.4 Submit Product Submittal sheets for tubing, manifolds, stand-up brackets, connection system, and fittings.
 - 1.4.2 Submit appropriate ULC or Warnock Hersey and CSA listings as proof of compliance with provincial building and plumbing codes.

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- 1.4.3 Include the following in the closeout documentation:
 - 1.4.3.1 Warranty documents specified in the Contract Documents.
 - 1.4.3.2 Manufacturer's field reports specified in this Section.
 - 1.4.3.3 Project record documents for installed materials in accordance with Section 20 00 00 - General Requirements.
- 1.4.4 Division 22 - Plumbing Subcontractor to prepare and submit an alternative compliance application under the OBC if stainless steel piping is used for domestic water service.
- 1.5 QUALITY ASSURANCE
 - 1.5.1 Qualifications:
 - 1.5.1.1 Installer experienced in performing work of this Section who has specialized in installation of work similar to that required for this project.
 - 1.5.1.2 Installation must be by skilled tradesmen holding a trade qualification license or apprentices under the supervision of a licensed tradesperson.
 - 1.5.2 Pre-installation Meetings:
 - 1.5.2.1 Conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.
- 1.6 DELIVERY, STORAGE AND HANDLING
 - 1.6.1 Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
 - 1.6.2 Deliver materials to job site in manufacturer's original, unopened, undamaged containers with identification labels intact.
 - 1.6.3 Store materials protected from exposure to harmful weather and job site conditions.
- 1.7 WARRANTY
 - 1.7.1 Refer to the Articles of Agreement, General Conditions and Section 20 00 00 - General Requirements for project warranty provisions.

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2 PRODUCTS

2.1 PIPES AND FITTINGS

2.1.1 For 860 kPa (125 psi) or less operating pressure use 860 kPa (125 psi) rated fittings. For 860 kPa to 1,730 kPa (125 psi to 250 psi) operating pressure use 1,730 kPa (250 psi) rated fittings.

2.1.2 Buried water lines:

2.1.2.1 Piping shall be IPEX "Blue Brute" PVC, 100mm – 300mm (4" – 12"), to Standards AWWA C900, CAN/CSA B137.3, ULC Cex448, UNI-B-3-80.

2.1.2.2 Fittings for 100, 150 and 200mm (4", 6" & 8") PVC pipe shall be injection moulded, colour coded blue with push-on gasketed joints conforming to AWWA C907 (latest revision), be ULC listed, FM approved and be certified by the Canadian Standards Association to CAN/CSA B 137.2. Injection moulded fittings shall be produced from 4000 psi HDB compound.

2.1.2.3 Gaskets shall be made of SBR. Gaskets must be removable from the pipe gasket race, in order to aid cleaning the bell and spigot should it be necessary prior to assembly.

2.1.2.4 Service connections to PVC mains shall be effected by using PVC moulded tapped couplings 100mm, 150mm & 200mm (4", 6" & 8") conform to AWWA C907 and be certified by the Canadian Standards Association to CAN/CSA B137.2.

2.1.2.5 Service saddles shall be stainless steel 304 and be a minimum 18-gauge (1.3mm) construction and shall have AWWA taper (CC) outlet thread. Service saddles shall be used for taps on pipe sizes larger than 200mm (8"), where tapped couplings cannot be used.

2.1.2.6 Mechanical joint restraints shall conform to ASTM F1674 and manufacturer's specifications. Restraining collars shall be attached to the fitting bell behind the gasket face. Tie-rods shall run from the collar behind the bell to a suitable collar on the connecting pipe. Tie-rods to be Denso wrapped.

2.1.2.7 Concrete thrust blocks shall conform to Ontario Provincial Standards Specification (OPSS) 1350 with nominal minimum 28-day compression strength of 20 MPa (2,900 psi). Thrust blocks as per UNI-B-3-92 and shall be constructed as per Ontario Provincial Standards Drawing (OPSD) 1103.01 and OPSD 1103.02.

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- 2.1.2.8 Tracer wire shall be 12-gauge Thermoplastic Water Resistant insulated wire, Nylon jacketed (TWN) multi-strand copper and shall be installed along all PVC watermain at the 12 o'clock position and as close to the pipe as possible. The tracer wire shall be brought to the surface at all fire hydrants, looped twice around the hydrant barrel 100mm (4") below finished grade and fastened by means of a washer to a breakaway flange bolt.
- 2.1.3 Domestic cold water, hot water, and hot water recirculation piping shall be type 'L' hard copper with wrought copper or cast brass fittings and 95/5 solder joints or brazed joints using phosphorus based filler metal, up to 1,380 kPa (200 psi) operating pressure.
- 2.1.3.1 Alternatively, for domestic cold water and hot water piping, 100mm (4") dia. and larger, stainless steel piping, Schedule 10 (up to 250 psi) / Schedule 40 (for operating pressure above 250 psi), conforming to AWWA Standard C220 with roll-grooved joints can be used.
- 2.1.3.2 Domestic cold water and hot water stainless steel piping shall conform to ASME B16.9 and ASTM A269 and only grade 304/304L and 316/316L shall be used.
- 2.1.4 Mechanical couplings (e.g. Victaulic) shall be permitted for domestic cold water, hot water and hot water recirculation systems, provided:
 - 2.1.4.1 The couplings are located in accessible locations unless otherwise approved by the engineer.
 - 2.1.4.2 All couplings are by one manufacturer, suitable for pressure and temperature of respective system.
 - 2.1.4.3 Rigid (Victaulic Style 107H Quick-Vic) couplings with offsetting angle bolt pads are used in mechanical rooms for Schedule 40 piping.
 - 2.1.4.3.1 Flexible (Victaulic Style 177) couplings may be used in equipment drops in lieu of flexible-connectors and where vibration attenuation and stress relief are required.
 - 2.1.4.4 Couplings for stainless steel roll-grooved plumbing piping to be manufactured from ductile iron conforming to ASTM-A536 and be complete with a Grade 'E' EPDM gasket, suitable for water service to 110°C (230°F) Couplings to be UL classified in accordance with ANSI/NSF-61 for potable water service.

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2.1.4.5 Couplings for copper grooved piping in size 50mm (2") and above to be designed to copper-tube dimensions with offsetting angle bolt pads to provide a rigid joint, (Victaulic Style 607) complete with EPDM flush-seal gasket suitable for temperatures from -34° (-30°F) to 110°C (230°F). Couplings to be UL classified in accordance with ANSI/NSF-61 for potable water service.

2.1.4.6 Fittings for copper piping shall be full flow copper fittings per ASTM B-75, or B-152, conform to ANSI B16.18 (cast copper alloy) or ANSI B16.22 (wrought copper), manufactured to copper-tube dimensions.

2.1.4.7 Couplings for stainless steel roll-grooved piping shall be with EPDM gaskets conforming to ANSI/NSF-61.

3 **EXECUTION**

3.1 GENERAL

3.1.1 Comply with manufacturer's product data, including Product technical bulletins, installation instructions, and Product carton instructions for installation.

3.1.2 Ream all piping and keep plugged to prevent entry of dirt. Use pipes, which conform to CSA and ASTM standards.

3.1.3 Install piping in a professional manner and in accordance with the practices of the trade.

3.1.4 Consider the piping shown on the Drawings as diagrammatic, for clearness in indicating the general runs and connections and that the piping may, or may not, in all parts be shown in the true position. This does not relieve the responsibility for the proper erection of the systems of piping in every respect suitable for the work intended.

3.1.5 Ensure that fabrication, welded or otherwise, meets the requirements of the ASA B31.9 Code for Pressure Piping, the CSA B51 Code for Boiler, Pressure Vessel, and Pressure Piping, and all requirements of the Boilers and Pressure Vessels Act of the Province of Ontario.

3.1.6 Use only fittings, or other materials to be incorporated in the work, which are approved by TSSA's Boiler and Pressure Vessels Safety Program, for the class of work for which they are used.

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- 3.1.7 Thoroughly clean the inside of fittings and outside of pipe with steel wool and coat with flux, before soldering or brazing any copper pipe work joint. Remove the working parts of valves before soldering or brazing commences, and replace after soldering or brazing is complete.
- 3.1.8 Provide swing joints in runouts to units, off horizontal mains.
- 3.1.9 In Victaulic grooved piping systems, install swing joints consisting of flexible couplings, pipe nipples and elbows that provide simultaneous movement in all directions. Refer to Victaulic design submittal #26.12.
- 3.1.10 Use di-electric connections for cathodic protection wherever pipes of dissimilar material are connected together. When connecting grooved end steel to copper piping, use Victaulic dielectric waterway, Style 647-GG.
- 3.1.11 All traps and fittings shall be of same material or equal in quality and thickness to the pipe to which they are connected.
- 3.1.12 Provide unions or flanges at all connections to equipment or fixtures requiring servicing or replacement.
- 3.1.12.1 Unions or flanges for servicing are not required in installations using Victaulic couplings. (The couplings shall serve as disconnect points.)
- 3.1.13 In copper pipes, provide wrought copper unions with soldered joints for pipe up to and including 50mm (2"), and 1,035 kPa (150 psi) cast brass flanges for pipes 65mm (2-1/2") or larger.
- 3.1.14 Install all grooved end components as per manufacturers' latest recommendation. All grooved products shall be of one manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products.
- 3.1.15 Provide thrust restraints on mechanical pipe joints where required to accommodate axial thrust. Scope of bracing shall include but not be limited to all joints at the base of all vertical storm drains, including cleanouts, and all joints in horizontal piping at the lowest level which drains by gravity to the street services.

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3.2 EQUIPMENT CONNECTIONS

- 3.2.1 Install piping connection to equipment, to prevent any strain on pipe and equipment and to facilitate removal equipment without disconnecting more than the minimum of pipework or shutting down any other piece of equipment.
- 3.2.2 Install equipment and apparatus requiring servicing and/or replacing with unions or flanges.
- 3.2.3 Install valves, and automatic valve assemblies prefabricated and in uniform arrangement.
- 3.2.4 Install piping, automatic control valves, thermostat wells, orifice plates, etc., and any other appurtenances, supplied under the work of other Specification Sections or by the Owner for insertion in piping and equipment.
- 3.2.5 Provide di-electric fittings between dissimilar metals where corrosion may occur.

3.3 CONNECTIONS FOR OTHER TRADES

- 3.3.1 Provide valved hot and/or cold water to all equipment supplied by others, requiring same and connect.
- 3.3.2 Provide quick fill valved connections for chilled water, hot water, and condenser water systems.
- 3.3.3 Provide valve bypass arrangement for water differential pressure transmitters. Coordinate exact quantity and location with the Division 25 - Integrated Automation Subcontractor.

3.4 TESTING

- 3.4.1 After all pipes have been placed in position and all branches installed, but before fixtures have been set or connected, test the tightness of all joints and the soundness of all pipes.
- 3.4.2 Make all tests before piping is furred in.
- 3.4.3 Notify the Consultant at least 48 hours before commencing with test, and give the Consultant a written certificate confirming these tests.
- 3.4.4 Test all water lines hydrostatically at 1-1/2 times the working pressure but at not less than 1,380 kPa (200 psi), for a period of

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not less than four (4) hours without any drop in pressure. Do testing before piping is buried or furred in and before pressure sensitive devices are installed in the pipework. Correct all defects disclosed by tests. Retest until all results are acceptable.

3.4.5 If any leaks are discovered by the above tests, remove and replace the faulty portions of the systems and repeat the test. Repeat this procedure until the system is accepted by the Consultant's representative on the Site. Do not caulk threaded joints.

3.4.6 Check horizontal pipe with an accurate level for any alterations in pitch. Inspect laterals, cross arms, and eliminate pockets. Correct any cases of water hammer.

3.5 FLUSHING AND CLEANING

3.5.1 Inspect the systems, and remove any heavy debris and excessive oil and dirt.

3.5.2 Flush all completed systems with clear water at the highest obtainable pressure and velocity.

3.5.3 During flushing and cleaning, maintain all isolating and control valves in the open position.

3.5.4 Sterilize domestic hot and cold water piping. Provide chemical and bacteriological test data to prove that sterilization has been carried out.

3.5.5 Flush, chlorinate and reflush all outside water mains in accordance with AWWA C651-05 Specifications.

3.6 STREET SERVICES

3.6.1 Connect building cold water services, fire water, main storm and sanitary sewers to street mains where shown, and make all necessary arrangements with authorities and utilities involved. Pay for all permits and inspections and for all work to be done by the local authorities and utility companies.

3.6.2 Check and verify all invert elevations before proceeding with any of the work of this Section.

3.7 COMPLETION

3.7.1 Provide a declaration, signed by a responsible officer of the Division 22 – Plumbing Subcontractor indicating that the following

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procedures and tests have been performed in accordance with the Drawings and Specifications. Provide two (2) copies of the signed declaration to the Consultant.

- 3.7.1.1 Water pressure test performed and leak free.
- 3.7.1.2 Plumbing inspections made and issue necessary certificates.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings for the following equipment:

1.2.1.1 Hose bibs

1.2.1.2 Water meter

1.2.1.3 Thermostatic mixing valves

1.2.1.4 Backflow preventers

1.2.1.5 Pressure reducing valves

1.2.1.6 Shock absorbers

1.2.1.7 Domestic hot water storage tanks

2 **PRODUCTS**

2.1 SHOCK ABSORBERS

2.1.1 Shock absorbers shall be P.P.P. Inc 'SS' Series.

2.2 HOSE BIBS

2.2.1 Outside wall hydrants ('N.F.W.H.') shall be non-freeze flush type with stainless steel box, polished nickel bronze hinged locking cover and key and integral vacuum breaker. J.R.Smith 5509-QTNB; Zurn Z-1300-SS; Mifab MHY-20-3; Watts HY-725-SS.

2.2.2 Non-freeze wall hydrants ('N.F.W.H.') shall be ¼ turn non-drip, ceramic cartridge, 19mm (¾") non-freeze wall type with bronze face, adjustable wall-flange operating key, and self-draining integral vacuum breaker. Length to suit wall thickness. J.R.Smith 5609-QT; Zurn Z-1310; Mifab MHY-16; Watts HY-420.

2.2.3 Inside hose bibs (H.B.) shall be with rough chrome plated, heavy duty, angled body, 12mm (½") with 19mm (¾") hose end vacuum breaker. Acorn 'Neptune' 8121CR; Watts SC8

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2.2.4 Inside combination cold and hot water hose bibs 'HB-2' in mechanical rooms and garbage rooms shall be DN15 (1/2") with DN20 (3/4") hose end vacuum breaker.

2.3 MAIN INCOMING WATER METER

2.3.1 Water meter for 2" and larger shall be 'Neptune Technology' TRU/FLO Compound Meter or equal, with digital pulse output.

2.3.2 Provide 3-valve by-pass around meter and drain valve.

2.3.3 Provide remote reading totalizer complete with wiring and plastic conduit.

2.3.4 Provide cold water meter couplers, tails and spacer tubes.

2.4 WATER SUB-METER

2.4.1 Water meter 2" and smaller shall be 'Neptune Technology' T-10 Meter, with digital pulse output.

2.4.2 Provide 3-valve by-pass around meter and drain valve.

2.4.3 Provide remote reading totalizer complete with wiring and plastic conduit.

2.4.4 Provide hot and cold water meter couplers, tails and spacer tubes.

2.5 BACKFLOW PREVENTERS

2.5.1 Provide backflow preventers in accordance with CAN/CSA-B64.10-11.

2.5.2 Acceptable Products for non-potable applications are as follows:

2.5.2.1 B64.4 Reduced Pressure Principle Type (RP) – Conbraco Series 40-200, Watts 009/909, Wilkins 975XL/975, Febco 825YA/YD, Hersey Grinnell FRP-2, Ames 4000.

2.5.2.2 B64.5 Double Check Valve Type (DCVA) – Conbraco Series 40-100, Watts 007/757, Wilkins 950XL/950, Febco 805/850, Hersey Grinnell FDC/HDC, Ames 2000/3000.

2.5.3 Acceptable Products for potable applications are as follows:

2.5.3.1 B64.4 Reduced Pressure Principle Type (RP) – Apollo Valves Series 40-200, Watts 009/909, Wilkins 375XL, Febco 825YA/YD,

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Ames 4000B (or 4000SS).

2.5.3.2 B64.5 Double Check Valve Type (DCVA) – Conbraco Series 40-100, Watts 007/757, Wilkins 950XL/950, Febco 805/850, Ames 2000/3000.

2.5.4 Use screwed connections to DN50 (2") size, flanged connections for larger sized valves, bronze or cast iron body, bronze trim, and stainless steel pilot trim.

2.5.5 Backflow preventers shall have a minimum working pressure of 1,724 kPa (250 psi).

2.6 PRESSURE REDUCING VALVES

2.6.1 Water Service – up to 1,035 kPa (150 psi)

2.6.1.1 DN15 to DN65 (½" to 2-½") – Watts Regulator Series #223 or Acceptable Alternative Manufacturers Pressure Reducing Valve, size as shown on the Drawings, bronze body, direct operated, single renewable seated stainless steel trim, diaphragm actuated.

2.6.1.2 DN80 to DN150 (3" to 6") - Watts Regulator Series #2300 or Acceptable Alternative Manufacturers Pressure Reducing Valve, size as shown on the Drawings, cast iron body, direct operated, single renewable seated stainless steel trim, diaphragm actuated.

2.6.2 Water Service – up to 2,070 kPa (300 psi)

2.6.2.1 DN15 to DN65 (½" to 2-½") – Watts Regulator Series #223 or Acceptable Alternative Manufacturers Pressure Reducing Valve, size as shown on the Drawings, bronze body, direct operated, single renewable seated stainless steel trim, diaphragm actuated.

2.6.2.2 DN80 to DN200 (3" to 8") - Watts Regulator Series #F115 or Acceptable Alternative Manufacturers Pressure Reducing Valve, size as shown on the Drawings, ductile iron body, pilot operated, stainless steel trim, diaphragm actuated, flanged suitable for 400 psi inlet pressure, with adjustable opening speed.

2.6.3 Valve shall regulate accurately throughout the range of pressures and flow conditions scheduled, function quietly, and shut tight on a dead end shut-off. Flanged or grooved ends, disc and diaphragms of hycar material. No springs shall be in the path of the water and no stuffing of boxes. All parts must be easily accessible without removal of the valve from the line. Provide Type 'Y' Strainer (Suffix

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‘S’) in front of PRV. Tested and certified to ASSE Std. 1003.

2.7 DOMESTIC HOT WATER STORAGE TANK

2.7.1 Domestic hot water storage tanks shall be A. O. Smith of type and size as shown on the drawings.

2.7.2 Tank shall be ASME rated steel with dished head, Monel tappings, and 380 x 280mm (15" x 11") access maintenance hole. Tanks shall be glass lined. Lining shall be guaranteed for five (5) years against any deterioration.

2.7.3 Tank shall be with the following:

2.7.3.1 ASME temperature and pressure relief valve

2.7.3.2 Two (2) 229mm (9") thermometers

2.7.3.3 Support saddles or legs OR Ring base for vertical installation.

2.8 BACKWASH FILTERS

2.8.1 Provide automatic operation protective backwash filters similar to Judo-Profi JPF+AT\P-100mm (4"). Filter shall be capable of handling up to 17 L/s (264 USgpm) water flow at maximum pressure drop of 1000 kPa (145 psi).

2.8.2 Filter upper housing shall be made of high-grade polymer based materials, bottom housing made of high-grade cast iron coated with rilsan. Filter shall be equipped with a clear sight-glass, which allows viewing the filtration, soiling and backwash functions. Filter shall have stainless steel screen with 0.1mm (0.004 inches) sieve size, silver plated for germ prophylaxis.

2.8.3 Automatic backwash shall be generated by a time actuated relay, with the following adjustable range from 1 to 2,000 hours and a differential pressure control setting adjustable from 6.9-248 kPa (1-36 psi) differential.

2.8.4 Back-washing shall utilize point rotation system without any interruption of the water supply. Simultaneous cleaning of the sight-glass during the backwash process.

2.8.5 Electronic control system shall include LED indicators for operation mode, alarm buzzer and manual override button for back-wash start-up. Filter shall be complete with 120/24 VAC plug-in transformer

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2.9 HOT WATER MIXING VALVES

- 2.9.1 Provide master thermostatic valves conforming to requirements of CSA B.125 to control valve discharge water temperature to 49°C (120°F). Select valves to provide the required maximum flow rate at a maximum pressure drop of 69 kPa (10 psi).
- 2.9.2 Thermostatic Valves shall be listed to ASSE 1017 – Temperature Actuated Mixing Valves For Hot Water Distribution Systems. Valves should also have Uniform Plumbing Code Canadian (cUPC) listing.
- 2.9.3 Valve body to cast bronze to ASTM B 584. Bronze internal components to ASTM B 139.
- 2.9.4 Valve shall have Manufacturer's name, as well as ASSE 1017 and cUPC logos, clearly displayed for conformance to standard.
- 2.9.5 Provide factory assembled and tested large TYPE TM thermostatic water mixing valve, small TYPE TM valve, DURA-trol® solid bi-metal thermostat (directly linked to valve porting to control the intake of hot and cold water and compensate for supply temperature or pressure fluctuations) with Seven Year Limited Warranty, color coded dials (HOT-COLD with directional indicators), locking temperature regulator handles, adjustable limit stops set for 49°C (120°F), integral hot and cold supply check stops.
- 2.9.6 Provide outlet ball valve shutoffs, color-coded dial thermometer, and inlet piping manifold.
- 2.9.7 Factory preassembled and hydrostatically tested to ASSE 1017 requirements, rough bronze finished system shall provide full time standby service should one mixing valve require maintenance.
- 2.9.8 Valves shall be piped strictly in accordance to Manufacturer's required piping method and be factory assembled and shipped to site for installation.
- ## 2.10 THERMOSTATIC FLOW REGULATOR
- 2.10.1 Flow regulator shall be Circuit Solver as manufactured by Therm-Omega-Tech, Inc., or equivalent, NSF-61 certified for use in all domestic water systems.

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- 2.10.2 Circuit Solver shall regulate the flow of recirculated domestic hot water based on water temperature entering the regulator regardless of system operating pressure.
- 2.10.3 Even when fully closed the Circuit Solver shall bypass a small amount hot water to maintain dynamic control of the recirculating loop.
- 2.10.4 Circuit Solver shall be factory adjustable as required by project conditions.
- 2.10.5 Circuit Solver shall be available in sizes ranging from DN15 (½ inch) NPT to DN50 (2") NPT, with standard tapered female pipe thread connection, rated to 1,378 kPa (200 psi) maximum operating pressure and to 148.9°C (300°F) maximum working temperature.
- 2.10.6 Body and all internal components shall be constructed of stainless steel with major components constructed of type 303 stainless steel.
- 2.10.7 Thermal actuator shall be spring loaded and self-cleaning, delivering closing thrust sufficient to keep orifice opening free of scale deposits.
- 2.11 **AUTOMATIC WATER BALANCING VALVES**
- 2.11.1 Potable Water Automatic Balancing Valves 15mm (½") – 20mm (¾"):
- 2.11.1.1 Designed specifically for use in drinking water applications. NSF Certified in accordance with ANSI/ NSF 61 for commercial cold and hot water service, rated to 83degC (180degF) and ANSI/NSF 372. Lead-free construction; Series 300 stainless steel body, nickel plated brass union nut and tamper-resistant flow cartridge in 300 series stainless steel. Valve shall be suitable for a flow range of 0.33 GPM/1.50 LPM to 12 GPM/45.4 LPM and flow rate pre-set accuracy variation of +/-5% over 95% of the control range. Valves shall be offered with two pressure differential control ranges of 2-3 psi/ 13-220 kPa or 5-60 psi/ 35-414 kPa differential.
- 2.11.2 Standard of Acceptance: Victaulic/ IMI TA Series 76X, RWV 9519-AB/9517-AB

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3 EXECUTION

3.1 UNIONS, FLANGES, DI-ELECTRIC COUPLINGS

- 3.1.1 Provide unions or flanges at all connections to equipment of fixtures requiring servicing or replacing.
- 3.1.2 In copper pipes, provide wrought copper unions with soldered joints for pipes up to and including DN50 (2") sizes and 1,034 kPa (150 psi) cast brass flanges for pipes DN100 (4") or larger.
- 3.1.3 Install approved dielectric isolation in following specified systems:
- 3.1.3.1 Domestic cold water systems
- 3.1.3.2 Make-up water systems
- 3.1.3.3 Expansion pipes where make-up is connecting to the expansion tank
- 3.1.3.4 In all other locations where specifically noted or shown on the Drawings
- 3.1.4 Install approved dielectric isolation at the transition between noble materials such as copper, brass bronze, high alloy castings, or stainless steel and low alloy ferrous materials such as black iron, galvanized iron, or cast iron. These dielectric isolators must be installed in such a way that they are not shorted out by accidental contacts to process equipment, building steel, instrumentation tubing, or electrical neutrals. Ensure that dielectric unions are constructed of materials that are compatible galvanically with the systems to which they are connected, e.g. a dielectric union for installation between copper and iron must be constructed with a body of iron and a tailpiece of copper or brass.

3.2 SHOCK ABSORBERS

- 3.2.1 Provide shock absorbers on both hot and cold water systems. Install in an upright position at all quick closing valves, solenoids, groups of plumbing fixtures and isolated fixtures. Locate and size as required and in accordance with the Plumbing and Drainage Institute Standard No. WH201 P.D.I. and as per manufacturer's instruction.

3.3 BACKFLOW PREVENTERS

- 3.3.1 Provide backflow preventers for all potential cross connections,

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including domestic water connections to all heating, cooling and refrigeration equipment, to irrigation system, where shown on drawings, and as required by the Ontario Plumbing Code and local authority having jurisdiction. As a minimum standard, installation shall be in conformance with CAN/CSA-B64.10-11.

3.3.2 Provide bronze body, spring loaded, soft seated, silent check valve upstream of backflow preventers. Up to and including DN50 (2"): Watts Series 600, Conbraco 61-500, Wilkins Model 40. DN65 (2-½") and above: Apco Series 300, Mueller.

3.3.3 Installation of silent check valve upstream of double check valves servicing main domestic water line is not required.

3.4 KITCHEN, AND OTHER OWNER'S EQUIPMENT

3.4.1 Provide complete roughing-in and final connections for kitchen, laboratory, and other Owner's equipment as shown on the drawings and as further delineated by the kitchen, laboratory, and other Owner's equipment drawings provided by the Owner and/or by other Specialist Consultants. This Subcontractor shall prepare complete 1:50 scale drawing with all services shown as required for approval by the Consultant.

3.4.2 No roughing-in shall be started and no final connections made to equipment until complete roughing-in and connection drawings have been provided by the Owner.

3.4.3 Provide valved and capped connections to equipment supplied by others.

3.4.4 When the equipment has been installed, do all final connections to equipment.

3.5 DOMESTIC HOT WATER STORAGE TANKS

3.5.1 Install tanks on 100mm (4") high concrete housekeeping pad.

3.5.2 Provide a temperature and pressure relief valve for each tank. Pipe to nearest drain.

3.6 BACKWASH FILTER

3.6.1 Run DN20 (¾") backwash flushing drain, two (2) connections for 100mm (4"), three (3) connections for 125mm (5") filter, to nearest large capacity funnel floor drain using an indirect connection.

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3.7 THERMOSTATIC FLOW REGULATOR

- 3.7.1 Install thermostatic flow regulator in each domestic hot water recirculation riser/branch beyond the last hot water device in that branch. Provide suitable line size isolation valves and access panel as required in non-accessible ceilings and walls.

3.8 WATER SUB-METER

- 3.8.1 Connect meters to metering system. Refer to and coordinate with Div. 26 for metering system. Provide all necessary components for a complete and functional metering system.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Domestic hot water circulators.

1.2.1.2 Domestic hot water recirculation pumps.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for:

1.3.1.1 Circulators

1.3.1.2 Recirculation pumps

1.3.2 Submit letter from manufacturer certifying domestic water booster pump system has been installed in accordance with its recommendations.

1.3.3 The submittal data for the pumping system shall include, but not be limited to: pump curves, individual computer data sheets, system drawings, and complete description of control panel, with wiring diagram, sequencing data, instrumentation and alarms.

2 **PRODUCTS**

2.1 DOMESTIC HOT WATER RECIRCULATING PUMP

2.1.1 Provide domestic hot water recirculating system consisting of pump and ancillaries.

2.1.2 Pump shall be bronze fitted.

2.1.3 Install line size butterfly, ball, or gate valves and strainer on pump suction. Install line size swing check valves and butterfly, ball, or gate valve on pump discharge.

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2.2 DOMESTIC HOT WATER CIRCULATORS

2.2.1 Provide domestic hot water circulation pumps for domestic hot water boilers, complete with ancillaries.

2.2.2 Pump shall be bronze fitted.

3 **EXECUTION**

3.1 GENERAL REQUIREMENTS

3.1.1 Provide pump and install it in accordance with the requirements of the respective manufacturer.

3.1.2 Ensure that the piping does not stress the pump casing because of misalignment.

3.1.3 After connections have been made, fill system before starting pump. Do not run dry under any circumstances.

3.1.4 Support piping from building structure to prevent any strain on pump casing. Make final check for alignment of piping connections before pump connections are tightened.

3.2 RECIRCULATING PUMPS AND CIRCULATORS

3.2.1 Install line size butterfly, ball, or gate valve and strainer on pump suction. Install line size swing check valve and butterfly, ball, or gate valve on discharge.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Sanitary system, including drains, and vents.

1.2.1.2 Floor drains and fittings.

1.3 REGULATORY REQUIREMENTS

1.3.1 In addition to specific requirements for pipe fittings as further specified in this document and where applicable, the equipment shall comply with the Boiler and Pressure Vessels Act (the "Act") and CSA Standard B51.

1.3.2 In compliance with the Act and relevant Codes, all fittings shall be registered by the manufacturer, and shall be identified by the appropriate Canadian registration number.

1.3.3 Where fittings are provided without the appropriate Canadian registration number, the Contractor shall obtain a copy of the manufacturer's Statutory Declaration as provided to the authorities having jurisdiction.

1.3.4 All welding and fabrication shall be to the requirements of the ANSI/ASME B31.9 code for pressure piping and CSA standard B51 code for the Construction and Inspection of Boilers and Pressure Vessels.

1.3.5 All copper piping shall be certified to ASTM Standard B88 for Seamless Copper Water Tube.

1.4 REFERENCES

1.4.1 ASTM D1784 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

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1.4.2 CAN/CSA B181.2 – PVC Drain, Waste and Vent Pipe and Pipe Fittings.

1.4.3 CAN/CSA B182.1 – Plastic Drain and Sewer Pipe and Pipe Fittings.

1.4.4 CAN/CSA B602 – Mechanical Couplings for Drain, Waste, and Vent Pipe and Sewer Pipe.

1.4.5 CAN/ULC-S102.2 Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.

1.4.6 CAN/ULC-S115 – Standard Method of Fire Tests of Firestop Systems

1.4.7 National Plumbing Code of Canada (NPC)

1.4.8 Ontario Building Code (OBC)

1.5 QUALITY ASSURANCE

1.5.1 Source Limitations: Obtain plastic piping and fittings from a single manufacturer.

2 **PRODUCTS**

2.1 PIPES AND FITTINGS

2.1.1 Buried sanitary drains:

2.1.1.1 Piping shall be IPEX “PVC BDS Solvent Weld” DR-35 100mm - 150mm (4” - 6”) CAN/CSA B182.1, or IPEX “Ring-Tite” PVC DR-35 100mm - 375mm (4” – 15”) CAN/CSA B182.2, to ASTM Standard D3034.

2.1.1.2 Fittings for 100, 125, 150, 200, 300, and 375-mm (4”, 5”, 6”, 8”, 10”, 12”, & 15”) PVC DR 35 pipe shall be injection-moulded or fabricated fittings, certified by the Canadian Standards Association to CAN/CSA B182.1 and B182.2. Pipe and fittings to be constructed by the same manufacturer to ensure compatibility.

2.1.1.3 Gaskets shall be factory installed and made of elastomer, EPDM. Nitrile gaskets shall be used, as determined by the Consultant, where contaminated soils or special chemical or temperature resistance is encountered or required.

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- 2.1.1.4 PVC injection-moulded or fabricated tees shall be used for all service connections on new sewer main construction, including sewer mains for new subdivisions prior to assumption.
- 2.1.1.5 The pipe shall be jointed in accordance with the manufacturer's specifications.
- 2.1.1.6 Tracer wire shall be installed with all PVC pipe.
- 2.1.2 Sanitary piping cast into raft footings shall be ABS DWV.
- 2.1.3 Unburied sanitary drains, 75mm (3") dia. and under shall be copper drainage tube (DWV), cast brass fittings and 50/50 solder joints. Drains 100mm (4") dia. and over shall be standard weight cast iron pipe and fittings with mechanical joints.
- 2.1.4 Vents 50mm (2") dia. and less shall be type DWV copper, 65mm (2-1/2") and over galvanized.
- 2.1.4.1 In lieu of the above specified piping, IPEX System XFR for use in in air plenums and High Buildings, and IPEX System 15 otherwise, may be used.
- 2.1.5 Fitting restraints for cast iron piping shall be HoldRite #117 series or approved equal. Field-devised methods and materials shall not be used to accomplish this application solution.

3 **EXECUTION**

3.1 GENERAL

- 3.1.1 Install in accordance with requirements of the Ontario Building Code or the local plumbing Authority Having Jurisdiction.
- 3.1.2 Ream all piping and keep plugged to prevent entry of dirt. Use pipes, which conform to CSA and ASTM standards.
- 3.1.3 Connect vent lines into the soil stack above highest fixture or extend separately through roof to a height of 600mm (24") above roofline and 3.6m (12 ft) away from any opening into building and flash properly.
- 3.1.4 Do not use double hubs, straight crosses, double T's or double TY's on any soil or waste pipe.
- 3.1.5 Install piping in a workmanlike manner and in accordance with current plumbing industry practices.

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- 3.1.6 Consider the piping shown on the Drawings as diagrammatic, for clearness in indicating the general runs and connections and that the piping may, or may not, in all parts be shown in the true position. This does not relieve the responsibility for the proper erection of the systems of piping in every respect suitable for the work intended.
- 3.1.7 Cleanouts and other service items must be accessible.
- 3.1.8 Penetrations through structure shall be such that structural loads are not transferred to pipes.
- 3.1.9 On screwed piping, make up joints, metal to metal with red or white lead and oil applied to the thread. No hemp wick or packing will be permitted in making up screwed joints.
- 3.1.10 Thoroughly clean the inside of fittings and outside of pipe with steel wool and coat with flux, before soldering any copper pipe work joint. Remove the working parts of valves before soldering commences, and replace after soldering is complete.
- 3.1.11 Use di-electric connections for cathodic protection wherever pipes of dissimilar material are connected together. When connecting grooved end steel to copper piping, use Victaulic dielectric waterway, Style 647-GG.
- 3.1.12 All traps and fittings shall be of same material or equal in quality and thickness to the pipe to which they are connected.
- 3.1.13 Provide unions or flanges at all connections to equipment or fixtures requiring servicing or replacement.
- 3.1.14 In copper pipes, provide wrought copper unions with soldered joints for pipe up to and including 50mm (2"), and 1,035 kPa (150 psi) cast brass flanges for pipes 65mm (2-1/2") or larger.
- 3.1.15 Install all grooved end components as per manufacturer's latest recommendation. All grooved products shall be of one manufacturer.
- 3.1.16 Provide fitting restraints on mechanical pipe joints where required to accommodate axial thrust. Fitting restraints shall include but not be limited to all fittings over 75mm (3") in size, at the base of all vertical sanitary drains serving more than 10 storeys, including cleanouts, and all joints in horizontal piping at the lowest level which drains by gravity to the street services.

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3.1.17 Provide fire-stop systems for all piping, at all penetrations through fire-rated separations tested and listed in accordance with CAN/ULC-S115.

3.2 TESTING

3.2.1 After all pipes have been placed in position and all branches installed, but before fixtures have been set or connected, test the tightness of all joints and the soundness of all pipes.

3.2.2 Make all tests before piping is furred in.

3.2.3 Notify the Consultant at least 48 hours before commencing with test, and give the Consultant a written certificate confirming these tests.

3.2.4 Sanitary, Waste, and Vent Piping: Securely close all openings in pipe ends throughout the work by means of approved plugs and fill the entire piping system, including stacks, branches to fixtures and all horizontal runs with water, up to highest opening and let this water stand at this level for not less than two (2) hours. Perform another test after the fixtures are set, connected, and connections are made to all equipment. Test by running water into all pipes, fixtures, traps, and apparatus in order to detect any imperfect material or workmanship. Where it is impossible to test the whole system at one time, divide into parts. Perform a smoke or ball test or any other test required by authorities having jurisdiction.

3.2.5 Test all pumped drain lines hydrostatically at 1-1/2 times the working pressure but at not less than 1,380 kPa (200 psi), for a period of not less than four (4) hours without any drop in pressure. Do testing before piping is buried or furred in and before pressure sensitive devices are installed in the pipework. Correct all defects disclosed by tests. Retest until all results are acceptable.

3.2.6 If any leaks are discovered by the above tests, remove and replace the faulty portions of the systems and repeat the test. Repeat this procedure until the system is accepted by the Consultant's representative on the site. Do not caulk threaded joints.

3.2.7 Check horizontal pipe with an accurate level for any alterations in pitch. Inspect laterals, cross arms, and eliminate pockets.

3.2.8 For PVC piping:

3.2.8.1 Testing to be conducted after all solvent weld joints have cured.

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- 3.2.8.2 Perform hydrostatic pressure test prior to the piping system being commissioned.
- 3.2.8.3 Pressure test underground piping systems before backfilling in accordance with requirements of the Ontario Building Code or the local plumbing Authority Having Jurisdiction.
- 3.2.8.4 Pressure test above-ground piping systems in accordance with requirements of the Ontario Building Code or the local plumbing Authority Having Jurisdiction.
- 3.2.8.5 As per manufacturer's instructions.
- 3.2.8.6 The system should be slowly filled with water and all air bled from the highest and farthest points in the installation.
- 3.2.8.7 Once the system has reached the desired test pressure, it should remain at this pressure for one hour.
- 3.2.8.8 During this time, visually inspect all joints for leaks.
- 3.2.8.9 If any leaks are discovered, remove and replace the faulty portion(s) of the system and allow to cure fully before re-testing.
- 3.2.8.10 Follow proper safety precautions and use protective equipment during testing.
- 3.2.8.11 Prepare test and inspection reports.
- 3.3 **DRAIN PIPES IN RAFT FOOTINGS**
 - 3.3.1 Firmly restrain piping by tying off to adjacent rebars for entire horizontal length.
 - 3.3.2 After leak test, leave water in pipe during concrete pour.
 - 3.3.3 Notify Consultant at least 48 hours before pour.
- 3.4 **FLUSHING AND CLEANING**
 - 3.4.1 General
 - 3.4.1.1 Inspect the systems, and remove any heavy debris and excessive oil and dirt.
 - 3.4.1.2 Flush all completed systems with clear water at the highest obtainable pressure and velocity.

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3.5 STREET SERVICES

- 3.5.1 Connect building main and sanitary sewer to street main where shown, and make all necessary arrangements with authorities and utilities involved. Pay for all permits and inspections and for all work to be done by the local authorities and utility companies.
- 3.5.2 Check and verify all invert elevations before proceeding with any of this Work.

3.6 COMPLETION

- 3.6.1 Provide a declaration, signed by a responsible officer of the Division 22 – Plumbing Subcontractor indicating that the following procedures and tests have been performed in accordance with the Drawings and Specifications. Provide two (2) copies of the signed declaration to the Consultant.
- 3.6.1.1 Pressure test performed and leak free.
- 3.6.1.2 Plumbing inspections made and issue necessary certificates.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings for the following equipment:

1.2.1.1 Floor drains

1.2.1.2 Trap primers

1.2.1.3 Grease interceptors

1.2.1.4 Catch basins

2 **PRODUCTS**

2.1 FLOOR DRAINS

2.1.1 Mechanical Rooms, Plenums and Unfinished Areas – ‘FD-1’

2.1.1.1 Cast iron body floor drain, flashing clamp with weep holes, adjustable top and 200mm (8”) diameter, heavy duty, nickel bronze grate. J.R.Smith 2320NB; Zurn ZN556; Mifab F1320C-1, Watts FD-320-1.

2.1.2 Finished Areas – ‘FD-2’

2.1.2.1 Cast iron body floor drain, reversible flashing clamp with weep holes, adjustable top and 125mm x 125mm (5” x 5”) square nickel bronze strainer. J.R.Smith 2005B; Zurn ZN415-Y; Mifab F1100C-S, Watts FD-100-C-L5-1.

2.1.3 Finished Areas (Heavy Duty) – ‘FD-3’

2.1.3.1 Cast iron body floor drain, reversible flashing clamp with weep holes, adjustable top and 125mm (5”) diameter, nickel bronze, 12mm (1/2”) thick secured strainer, full 100mm (4”) throat opening. J.R.Smith 2005AHD; Zurn ZZN415-A; Mifab F1100CX, Watts FD-100-C-5-1.

2.1.4 Electrical Rooms, Transformer Vault, Switchgear Room – ‘FD-4’

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2.1.4.1 Same as 'FD-1', but with backwater valve. J.R.Smith 2320NB-BV; Zurn ZN556-X; Mifab F1320C-1-8, Watts FD-320-1-8.

2.1.5 Garbage Room, Loading Area – 'FD-5'

2.1.5.1 Cast iron body drain, flashing clamp with weep holes, adjustable top, 280mm x 280mm (11" x 11") hinged, vandalproof, cast iron bar grate, and 100mm (4") deep, slotted sediment bucket. J.R.Smith 2360-HSU; Zurn Z-610-H-VP; Mifab F1340C-5-6-14-16, Watts FD-460-AF-5-6-9.

2.2 HUB DRAINS

2.2.1 Unfinished Areas – 'HD-1'

2.2.1.1 Cast iron body drain, reversible flashing clamp with weep holes and cast iron hub adaptor. J.R.Smith 2005-2645; Zurn Z415-1030; Mifab F1100C-DD-50, Watts FD-100-C-DD-50.

2.2.2 Finished Areas – 'HD-2'

2.2.2.1 Cast iron body drain, reversible flashing clamp with weep holes and nickel bronze hub adaptor. J.R.Smith 2005-2645NB; Zurn ZN415-1030; Mifab F1100C-DD-1, Watts FD-100-C-DD-1.

2.3 FUNNEL FLOOR DRAINS

2.3.1 Unfinished Areas – 'FFD-1'

2.3.1.1 Cast iron body combination funnel and floor drain, reversible flashing clamp with weep holes, adjustable top, 200mm (8") diameter, heavy duty, cast iron grate 13mm (1/2") thick strainer with 89mm x 229mm (3-1/2" x 9") cast iron funnel. J.R.Smith 2320-3591-CI; Zurn Z556 with Z414-1; Mifab F1320C-G-50, Watts FD-320-G-50.

2.3.2 Finished Areas – 'FFD-2'

2.3.2.1 Cast iron body combination funnel and floor drain, reversible flashing clamp with weep holes, adjustable top, 125mm (5") diameter, nickel bronze, 6mm (1/4") thick secured strainer with 100mm (4") diameter nickel bronze funnel. J.R.Smith 2005A-3580NB; Zurn ZN415-B with ZN414; Mifab F1100C-F4-1, Watts FD-100-C-EF-1.

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2.3.3 Large Capacity, Unfinished Areas – ‘FFD-3’

2.3.3.1 Cast iron body combination funnel and floor drain, reversible flashing clamp with weep holes, adjustable top, 200mm (8") diameter, heavy duty, cast iron grate 13mm (1/2") thick with 125 x 375mm (5" x 15") cast iron funnel. J.R.Smith 2320-3592; Zurn Z556 with Z414-2, Watts FD-320-G-50.

2.4 TRAP PRIMERS

2.4.1 One to Four Drain

2.4.1.1 Provide P.P.P MP-500 complete with adjustable timer trap seal primer. Tap size to be 15mm (1/2") with integral stainless steel screen. Electrical components shall include circuit breaker, test switch, timer solenoid valve (UL listed) and 120V/1Ph/60Hz connection.

2.4.2 More than Four Drain

2.4.2.1 Provide P.P.P. PT complete with adjustable timer trap seal primer. Primer shall be activated by a 20mm (3/4") normally closed solenoid valve. Manifold shall be prefabricated type "L" copper tubing. Electrical components shall include circuit breaker, switch, timer, solenoid valve (UL Listed). Electronic assembly tested and certified to UL73. Electrical connection shall be 120V/1Ph/60Hz. Cabinet shall be 356mm x 406mm x 86mm made from 16 GA steel and galvanized. Access door shall be prime coated steel complete with screw driver latch.

3 **EXECUTION**

3.1 TRAPS

3.1.1 Provide every fixture and floor drain with traps in accordance with local regulations. Provide each trap with its own brass plug and ferrule cleanout.

3.1.2 For traps located in ceilings, provide access doors.

3.1.3 For drains in apparatus casings or air plenums, provide deep seal trap. For drains in outside air plenums, provide running trap located as far as possible from drains.

3.1.4 All traps for floor and hub drains shall be protected with trap primers. For electronic trap primers, run line voltage wiring to the nearest electrical panel with spare circuit.

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- 3.1.5 Division 22 contractor must coordinate with electrical trade for circuit locations during scope drawing stage, otherwise Division 22 trade will be responsible for all costs associated with circuit wiring.
- 3.1.6 Trap seal primers must be installed above finished floor. Piping must have a minimum of 300mm (12") from bottom of outlet before 90 degree elbow can be used. Furthest distance from primer to floor drain is 6m. Trap primer make up line must have a continuous slope to the floor drain.
- 3.1.7 If required by authorities having jurisdiction, provide building traps complete with cleanout and fresh air inlet with special grilles to meet the Consultant's approval.

3.2 DRAINS

- 3.2.1 In all areas with seamless flooring and plastic terrazzo finishes provide special flanges. These flanges shall be 100mm (4") larger in diameter than the drain top or sleeve diameter, and located approximately 5mm ($\frac{3}{16}$ ") below the top flanges to be of the same material as the drain finish.
- 3.2.2 Provide special flanges for the following items as described above:
 - 3.2.2.1 Floor drains
 - 3.2.2.2 Hub drains
 - 3.2.2.3 Combination drains

3.3 UNIONS, FLANGES, DI-ELECTRIC COUPLINGS

- 3.3.1 Provide unions or flanges at all connections to equipment of fixtures requiring servicing or replacing.
- 3.3.2 In copper pipes, provide wrought copper unions with soldered joints for pipes up to and including DN50 (2") sizes and 1,034 kPa (150 psi) cast brass flanges for pipes DN100 (4") or larger.
- 3.3.3 Install approved dielectric isolation in following specified systems:
 - 3.3.3.1 In all locations where specifically noted or shown
 - 3.3.4 Install approved dielectric isolation at the transition between noble materials such as copper, brass bronze, high alloy castings, or stainless steel and low alloy ferrous materials such as black iron, galvanized iron, or cast iron. These dielectric isolators must be

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installed in such a way that they are not shorted out by accidental contacts to process equipment, building steel, instrumentation tubing, or electrical neutrals. Ensure that dielectric unions are constructed of materials that are compatible galvanically with the systems to which they are connected, e.g. a dielectric union for installation between copper and iron must be constructed with a body of iron and a tailpiece of copper or brass.

3.4 KITCHEN AND OTHER OWNER'S EQUIPMENT

- 3.4.1 Provide complete roughing-in and final connections for kitchen, laboratory, and other Owner's equipment as shown on the Drawings and as further delineated by the kitchen, laboratory, and other Owner's equipment drawings provided by the Owner. Contractor shall prepare complete 1:50 scale drawing with all services shown as required for approval by the Consultant.
- 3.4.2 No roughing-in shall be started and no final connections made to equipment until complete roughing-in and connection drawings have been provided by the Owner.
- 3.4.3 Provide a complete venting system as part of the roughing-in. Venting shall be acceptable to the local plumbing inspector.
- 3.4.4 Provide capped connections to equipment supplied by others.
- 3.4.5 When the equipment has been installed, do all final connections to equipment.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Storm drainage system.

1.3 REGULATORY REQUIREMENTS

1.3.1 In addition to specific requirements for pipe fittings as further specified in this document and where applicable, the equipment shall comply with the Boiler and Pressure Vessels Act (the "Act") and CSA Standard B51.

1.3.2 In compliance with the Act and relevant Codes, all fittings shall be registered by the manufacturer, and shall be identified by the appropriate Canadian registration number.

1.3.3 Where fittings are provided without the appropriate Canadian registration number, the Contractor shall obtain a copy of the manufacturer's Statutory Declaration as provided to the authorities having jurisdiction.

1.3.4 All welding and fabrication shall be to the requirements of the ANSI/ASME B31.9 code for pressure piping and CSA standard B51 code for the Construction and Inspection of Boilers and Pressure Vessels.

1.3.5 All copper piping shall be certified to ASTM Standard B88 for Seamless Copper Water Tube.

2 **PRODUCTS**

2.1 PIPES AND FITTINGS

2.1.1 For 860 kPa (125 psi) or less operating pressure use 860 kPa (125 psi) rated fittings. For 860 kPa to 1,730 kPa (125 psi to 250 psi) operating pressure use 1,730 kPa (250 psi) rated fittings.

2.1.2 Buried storm drains:

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- 2.1.2.1 Piping shall be IPEX "Ring-Tite" PVC DR-35 (345 kPa – 50 psi), 100mm - 150mm (4" - 6") CAN/CSA B1800, 200mm - 375mm (8" – 15") CAN/CSA B1800, to ASTM Standard D3034.
- 2.1.2.2 Fittings for 100, 125, 150, 200, 300, and 375-mm (4", 5", 6", 8", 10", 12", & 15") PVC DR 35 pipe shall be injection-moulded fittings, certified by the Canadian Standards Association to CAN/CSA B182.1 and B182.2. Pipe and fittings to be constructed by the same manufacturer to ensure compatibility.
- 2.1.2.3 Gaskets shall be factory installed and made of elastomer, EPDM. Nitrile gaskets shall be used, as determined by the Consultant, where contaminated soils, special chemical, or temperature resistance is encountered or required.
- 2.1.2.4 PVC injection-moulded or fabricated tees shall be used for all service connections on new sewer main construction, including sewer mains for new subdivisions prior to assumption.
- 2.1.2.5 The pipe shall be jointed in accordance with the manufacturer's specifications.
- 2.1.2.6 Tracer wire shall be installed with all PVC pipe.
- 2.1.3 Storm drain piping cast into raft footings shall be ABS DWV.
- 2.1.4 Unburied storm drains, 75mm (3") dia. and under shall be copper drainage tube (DWV), cast brass fittings and 50/50 solder joints. Drains 100mm (4") dia. and over shall be standard weight cast iron pipe and fittings with mechanical joints.
- 2.1.5 Fitting restraints for cast iron piping shall be HoldRite #117 series or approved equal. Field-devised methods and materials shall not be used to accomplish this application solution.
- 2.1.6 Pumped storm drains shall be Schedule 40 galvanized steel pipe; stretch reduced continuous weld, ASTM A53, with screwed fittings.
- 2.1.6.1 In lieu of the above specified piping, DWV piping with cast brass fittings and 50/50 solder joints may be used.
- 2.1.7 Mechanical couplings (e.g. Victaulic) shall be permitted for pumped storm drain system, provided:
 - 2.1.7.1 The couplings are located in accessible locations.
 - 2.1.7.2 All couplings are by one manufacturer, suitable for pressure and

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temperature of respective system.

- 2.1.7.3 Rigid (zero-flex or equivalent) couplings with angle bolt pads are used in mechanical rooms.
- 2.1.7.4 Couplings for Schedule 40 piping to be manufactured from ductile iron conforming to ASTM-A536 and be complete with a Grade 'E' EPDM gasket, suitable for water service to 110°C (230°F).
- 2.1.7.5 Couplings for copper grooved piping in size 50mm (2") and above to be designed with angle bolt pads to provide a rigid joint, complete with EPDM flush-seal gasket suitable for temperatures from -34° (-30°F) to 110°C (230°F).
- 2.1.7.6 Fittings for Schedule 40 piping shall be manufactured from ductile iron conforming to ASTM-A536 or segmentally welded steel, with grooves designed to accept grooved end couplings.
- 2.1.7.7 Fittings for copper piping shall be full flow copper fittings per ASTM B-75, or bronze sand casting per ASTM B-584.

3 **EXECUTION**

3.1 GENERAL

- 3.1.1 Ream all piping and keep plugged to prevent entry of dirt. Use pipes, which conform to CSA and ASTM standards.
- 3.1.2 Do not use double hubs, straight crosses, double T's or double TY's on any waste pipe.
- 3.1.3 Install piping in a professional manner and in accordance with current plumbing industry practices.
- 3.1.4 Consider the piping shown on the Drawings as diagrammatic, for clearness in indicating the general runs and connections and that the piping may, or may not, in all parts be shown in the true position. This does not relieve the responsibility for the proper erection of the systems of piping in every respect suitable for the work intended.
- 3.1.5 On screwed piping, make up joints, metal to metal with red or white lead and oil applied to the thread. No hemp wick or packing will be permitted in making up screwed joints.
- 3.1.6 Ensure that welding is performed, using either gas or electric welding equipment. Thoroughly clean pipe surfaces and level the

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ends of each pipe and fitting before welding. Securely align and space piping so that the width of circumferential welds is two and one-half times the pipe wall thickness. Ensure that the deposited metal forms a gradual increase in thickness from the outside surface to the centre of the weld.

- 3.1.7 Ensure that the pipe welding is done by a welder holding a certificate from the Department of Labour for the class of piping to be welded.
- 3.1.8 When welding or cutting with a torch, take every precaution to prevent fire. Ensure that welding or torch cutting operators have a fully charged 4.5kg (10 lb.) carbon dioxide fire extinguisher with them, when welding or cutting in building, or tunnels. Protect wooden structures with asbestos blanket.
- 3.1.9 Ensure that fabrication, welded or otherwise, meets the requirements of the ASA B31.9 Code for Pressure Piping, the CSA B51 Code for Boiler, Pressure Vessel, and Pressure Piping, and all requirements of the Boilers and Pressure Vessels Act of the Province of Ontario.
- 3.1.10 Use only fittings, or other materials to be incorporated in the work, which are approved by TSSA's Boiler and Pressure Vessels Safety Program, for the class of work for which they are used.
- 3.1.11 Thoroughly clean the inside of fittings and outside of pipe with steel wool and coat with flux, before soldering any copper pipe work joint. Remove the working parts of valves before soldering commences, and replace after soldering is complete.
- 3.1.12 Use di-electric connections for cathodic protection wherever pipes of dissimilar material are connected together. When connecting grooved end steel to copper piping, use Victaulic dielectric waterway, Style 47-GG.
- 3.1.13 All fittings shall be of same material or equal in quality and thickness to the pipe to which they are connected.
- 3.1.14 Provide unions or flanges at all connections to equipment requiring servicing or replacement.
- 3.1.15 In copper pipes, provide wrought copper unions with soldered joints for pipe up to and including 50mm (2"), and 1,035 kPa (150 psi) cast brass flanges for pipes 65mm (2-1/2") or larger.
- 3.1.16 Install all grooved end components as per manufacturer's latest

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recommendation. All grooved Products shall be of one manufacturer.

- 3.1.17 Provide fitting restraints on mechanical pipe joints where required to accommodate axial thrust. Fitting restraints shall include but not be limited to all fittings over 75mm (3") in size, at the base of all vertical storm drains, including cleanouts, and all joints in horizontal piping at the lowest level, which drains, by gravity to the street services.

3.2 TESTING

- 3.2.1 After all pipes have been placed in position and all branches installed, test the tightness of all joints and the soundness of all pipes.
- 3.2.2 Make all tests before piping is furred in.
- 3.2.3 Notify the Consultant at least 48 hours before commencing with test, and give Consultant a written certificate confirming these tests.
- 3.2.4 Storm Drain Piping: Securely close all openings in pipe ends throughout the work by means of approved plugs and fill the entire piping system, including stacks, branches to drain and all horizontal runs with water, up to highest opening and let this water stand at this level for not less than two (2) hours. Perform another test after the fixtures are set, connected, and connections are made to all equipment. Test by running water into all pipes, drain, and apparatus in order to detect any imperfect material or workmanship. Where it is impossible to test the whole system at one time, divide into parts. Perform a smoke or ball test or any other test required by authorities having jurisdiction.
- 3.2.5 If any leaks are discovered by the above tests, remove and replace the faulty portions of the systems and repeat the test. Repeat this procedure until the system is accepted by the Consultant's representative on the Site. Do not caulk threaded joints.
- 3.2.6 Check horizontal pipe with an accurate level for any alterations in pitch. Inspect laterals, cross arms, and eliminate pockets. Correct any cases of water hammer.

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3.3 DRAIN PIPES IN RAFT FOOTINGS

3.3.1 Firmly restrain piping by tying off to adjacent rebars for entire horizontal length.

3.3.2 After leak test, leave water in pipe during concrete pour.

3.3.3 Notify Consultant at least 48 hours before pour.

3.4 FLUSHING AND CLEANING

3.4.1 General

3.4.1.1 Inspect the systems, and remove any heavy debris and excessive oil and dirt.

3.4.1.2 Flush all completed systems with clear water at the highest obtainable pressure and velocity.

3.4.1.3 During flushing and cleaning, maintain all isolating and control valves in the open position.

3.5 STREET SERVICES

3.5.1 Connect building main storm sewer to street main where shown, and make all necessary arrangements with authorities and utilities involved. Pay for all permits and inspections and for all work to be done by the local authorities and utility companies.

3.5.2 Check and verify all invert elevations before proceeding with any work of this Section.

3.6 COMPLETION

3.6.1 Provide a declaration, signed by a responsible officer of the Division 22 – Plumbing Subcontractor indicating that the following procedures and tests have been performed in accordance with the Drawings and this Specifications. Provide two (2) copies of the signed declaration to the Consultant.

3.6.1.1 Water pressure test performed and leak free.

3.6.1.2 Plumbing inspections made and issue necessary certificates.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings for the following equipment:

1.2.1.1 Roof drains

1.2.1.2 Scupper drains

2 **PRODUCTS**

2.1 SCUPPER DRAINS

2.1.1 Backwater Valve in Branch Mains – 'BV'

2.1.2 Flush Scupper Drain – 'SD-1'

2.1.2.1 Cast iron body flush scupper drain, flashing clamp, 45° threaded outlet and secured, vandalproof, nickel bronze flush grate. J.R.Smith 1540T-U-NB, Zurn ZN189-VP, Mifab R1330T-1-6, Watts RD-290-1-6.

2.2 ROOF DRAINS

2.2.1 Conventional Flow Roof Drains– 'RD-1'

2.2.1.1 Cast iron body roof drain, 387mm (15-1/4") dia., under deck clamp, solid extension and sump receiver, flashing clamp with weep holes and 280mm (11") dia. secured cast iron dome. J.R.Smith 1010-ERCCID; Zurn ZC-100-C-E-R; Mifab R1200BUV-M, Watts RD-100-BED-K. For inverted roof installation use perforated stainless steel extension. J.R.Smith 1017-RCCID; Zurn ZC-100-C-R-85; Mifab R1200JC-B-M-U, Watts RD-100-CJ-BED-K.

3 **EXECUTION**

3.1 CLEANOUTS AND CLEANOUT ACCESS COVERS

3.1.1 Cleanouts on drains outside building shall be brought up to grade with a DN100 (4") 'Y' and 1/8th bend in medium weight drain pipe with solid brass recess plug-in top. Provide necessary support for

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the drain pipe and set cleanout flush with grade in a 300mm by 300mm by 150mm (12" x 12" x 6") concrete pad.

3.1.2 In all areas with seamless flooring and plastic terrazzo finishes provide special flanges. These flanges shall be 100mm (4") larger in diameter than the drain or cleanout top of sleeve diameter, and located approximately 5mm ($\frac{3}{16}$ ") below the top flanges to be of the same material as the drain or cleanout finish.

3.1.3 Provide special flanges for the following items as described above:

3.1.3.1 Cleanouts

3.2 UNIONS, FLANGES, DI-ELECTRIC COUPLINGS

3.2.1 Provide unions or flanges at all connections to equipment requiring servicing or replacing.

3.2.2 In copper pipes, provide wrought copper unions with soldered joints for pipes up to and including DN50 (2") sizes and 1,034 kPa (150 psi) cast brass flanges for pipes DN100 (4") or larger.

3.2.3 Install approved dielectric isolation in following specified systems:

3.2.3.1 In all locations where specifically noted or shown on the Drawings.

3.2.4 Install approved dielectric isolation at the transition between noble materials such as copper, brass bronze, high alloy castings, or stainless steel and low alloy ferrous materials such as black iron, galvanized iron, or cast iron. These dielectric isolators must be installed in such a way that they are not shorted out by accidental contacts to process equipment, building steel, instrumentation tubing, or electrical neutrals. Ensure that dielectric unions are constructed of materials that are compatible galvanically with the systems to which they are connected, e.g. a dielectric union for installation between copper and iron must be constructed with a body of iron and a tailpiece of copper or brass.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the drawings and specified herein, including:

1.2.1.1 Electric domestic hot water heaters.

1.3 SUBMITTALS

1.3.1 Submit shop drawings for:

1.3.1.1 Electric domestic hot water heaters

1.3.2 As a minimum provide the following information:

1.3.2.1 Data sheets for heaters.

1.3.2.2 Power and control wiring diagrams.

1.3.2.3 Physical outline dimensions showing clearances, and connection entries.

1.3.2.4 Boiler control panel specification, sequence of operation.

1.3.3 Submit letter from boiler manufacturer certifying that boiler and all appurtenances have been installed in accordance with their recommendations.

2 **PRODUCTS**

2.1 ELECTRIC DOMESTIC HOT WATER HEATERS

2.1.1 Provide water heaters with capacity as shown on Drawings.

2.1.2 Water heaters shall have the ULC seal of certification and be factory equipped with an AGA/ASME rated temperature and pressure relief valve.

2.1.3 Water heaters shall meet or exceed the standby loss requirements

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of ASHRAE Standard 90.1-2010.

- 2.1.4 Tanks shall have a working pressure of 1,035 kPa (150 psi), and shall be completely assembled.
- 2.1.5 Floor mount water heater tank shall have a double coating of high temperature porcelain enamel and furnished with magnesium anode rods rigidly supported. Heater shall be equipped with "screw-in" type elements featuring a stainless steel outer sheath of INCO-LOY 840 material. Tank shall be insulated with 75mm (3") of rigid polyurethane foam insulation. Heater shall be constructed with an element diagnostic panel utilizing light emitting diodes. Each LED will correspond to the number and location of the heating elements and monitor their on-off function. Water heater shall be provided with internal power circuit fusing, control circuit fusing, magnetic contactors, 120 Volt control circuit transformer and immersion thermostats with manual reset high limit control.
- 2.1.6 Ceiling mount water heater tank interior shall be coated with a high temperature porcelain enamel and furnished with an R-Tech resistored magnesium anode rod rigidly supported. Water heaters shall be equipped with a copper, resistored, "screw-in" type element. Tank shall be insulated with rigid polyurethane foam insulation. Water heaters shall be equipped with a surface mounted thermostat with an integral, manual reset, high limit control.
- 2.1.7 Water heaters shall be covered by a three-year limited warranty against tank leaks.

3 **EXECUTION**

3.1 GENERAL

- 3.1.1 Provide a temperature and pressure relief valve for each water heater. Pipe to nearest drain.
- 3.1.2 Line side power wiring shall be provided by Division 26 - Electrical. Provide certified wiring schematics to Division 26 - Electrical for associated equipment.
- 3.1.3 Field control wiring of local safeties and interlocks shall be provided by this Section.
- 3.1.4 Flush and clean boilers on completion of installation, according to manufacturer's written instructions.

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- 3.1.5 After completing boiler installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes including chips, scratches, and abrasions with manufacturer's stainless steel polish.
- 3.1.6 Provide two (2) site visits during installation with written reports forwarded to the Consultant.
- 3.1.7 Provide complete start up service to set all controls. Include both initial startup as well as follow-up. Recalibrate all controls as required.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings for the following equipment:

1.2.1.1 Plumbing fixtures and brass.

1.2.1.2 Fixture carriers and other appurtenances.

2 **PRODUCTS**

2.1 FIXTURES

2.1.1 Toilet – Floor Mounted with Concealed Flush Valve – WC-1

2.1.1.1 American Standard 'MADERA Flowise' Elongated #3463001.020 Toilet, white vitreous china with EverClean antimicrobial surface, floor mounted, 4.2L to 6L (1.1 US Gal to 1.6 US Gal) per flush, floor outlet. Centoco #500STSCCFE.001 heavy duty toilet seat, for elongated bowl open front, white solid plastic, less cover, reinforced stainless steel check hinges, metal flat washers stainless steel posts and nuts. Sloan SL-ROYAL #140-1.28-WB-ESS flush valve, automatic concealed water closet flushometer, hardwired, constructed from semi-red brass, rough brass finish, high efficiency 4.8 LPF (1.28 GPF). Sloan SL-EL-154 Faucet and Flush Valve power kit for flush valve. Watts #WCA-411 floor mounted concealed carrier, adjustable arms, epoxy coated cast iron. Mission BAND-SEAK P Series shielded Specialty transition coupling, One-piece molded elastomeric sealing gasket, For non-pressure gravity flow applications only, (2 or 4) Type 301 stainless steel worm drive clamps, Meets & exceeds performance standard ASTM C1460, Rubber conforms to ASTM C564.

2.1.2 Toilet – Floor Mounted with Concealed Flush Valve - BF – WC-2

2.1.3 American Standard 'MADERA Flowise' Elongated #3463001.020 Toilet, white vitreous china with EverClean antimicrobial surface, floor mounted, 4.2L to 6L (1.1 US Gal to 1.6 US Gal) per flush, floor outlet. Centoco #500STSCCFE.001 heavy duty toilet seat, for elongated bowl open front, white solid plastic, less cover, reinforced stainless steel check hinges, metal flat washers

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stainless steel posts and nuts. Sloan SL-ROYAL #140-1.28-WB-ESS flush valve, automatic concealed water closet flushometer, hardwired, constructed from semi-red brass, rough brass finish, high efficiency 4.8 LPF (1.28 GPF). Sloan SL-EL-154 Faucet and Flush Valve power kit for flush valve. Watts #WCA-411 floor mounted concealed carrier, adjustable arms, epoxy coated cast iron. Mission BAND-SEAK P Series shielded Specialty transition coupling, One-piece molded elastomeric sealing gasket, For non-pressure gravity flow applications only, (2 or 4) Type 301 stainless steel worm drive clamps, Meets & exceeds performance standard ASTM C1460, Rubber conforms to ASTM C564. Franke Commercial Backrest #CM-16104, wall mounting, back rest, solid core plastic laminate

2.1.4 Lavatory – Wall Hung – LAV-1

2.1.5 American Standard 0955001EC.020 0059020EC.020 Basin - MURRO, Wall-hung Lavatory, Vitreous china, EverClean® antimicrobial surface, White finish. Sloan EBF-415-BAT-TEE-CP-0.35GPM-MLM-IR-FCT Faucet - OPTIMA®, Automatic no-touch, Optional hardwired power (battery as a back-up), 24 VAC power harness connector supplied, Lavatory faucet. Sloan SL-EL-154 Faucet and Flush Valve Power Kit - For flush valve. Chicago Faucets 131-CFMAB Mixing Valve - Point of use, Tempered water mixer, NSF/ANSI 61 compliant, Integral inlet check valves to protect against cross-flow. McGuire 155A Fixture Drain - Straight drain, Cast brass, Chrome-plated finish. McGuire LFH165LKN3 Supply - HEAVY PREMIERE Line Heavy pattern Faucet Supply kit, consisting of (2) stop valves, (2) risers, (2) flanges (standard), Lead Free Chrome-plated finish Brass body, Loose key handle, Angle stop, 305 mm (12") C.P. lavatory flexible copper riser tubes (standard), 10 mm (3/8") I.P.S. inlet x 10 mm (3/8") O.D.. McGuire 8872C P-Trap - Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") distance, With cleanout plug. Watts WCA-411-CA-481 Carrier - WCA-411/WCA-411-WC, Lavatory carrier, For concealed arm carrier, adjustable arms, epoxy coated cast iron, Wall mounted steel support plate with plated hardware.

2.1.6 Lavatory – Wall Hung – LAV-2

2.1.7 American Standard 0955001EC.020 0059020EC.020 Basin - MURRO, Wall-hung Lavatory, Vitreous china, EverClean® antimicrobial surface, White finish. Sloan EBF-415-BAT-TEE-CP-0.35GPM-MLM-IR-FCT Faucet - OPTIMA®, Automatic no-touch, Optional hardwired power (battery as a back-up), 24 VAC power harness connector supplied, Lavatory faucet. McGuire 155A

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Fixture Drain - Straight drain, Cast brass, Chrome-plated finish.
 McGuire LFCK165LK Supply - ICV DEFENDER Faucet Supply kit, consisting of (2) stop valves, (2) risers, (2) flanges (standard), Lead Free Chrome-plated finish Brass body, Loose key handle, Angle stop, 305 mm (12") C.P. lavatory flexible copper riser tubes (standard), 10 mm (3/8") I.P.S. inlet x 10 mm (3/8") O.D.. McGuire 8872C P-Trap - Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") distance, With cleanout plug. Watts WCA-411-CA-481 Carrier - WCA-411/WCA-411-WC, Lavatory carrier, For concealed arm carrier, adjustable arms, epoxy coated cast iron, Wall mounted steel support plate with plated hardware. Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, mechanical mixing valve. Sloan SL-EL-154 Faucet and Flush Valve Power Kit - For flush valve.

2.1.8 Lavatory – Semi-counter Mounted – BF – LAV-3

2.1.9 American Standard 9960001.020 Basin - MEZZO, Semi-countertop Lavatory, Fine fire clay, White finish. Sloan EBF-415-BAT-TEE-CP-0.35GPM-MLM-IR-FCT Faucet - OPTIMA®, Automatic no-touch, Optional hardwired power (battery as a back-up), 24 VAC power harness connector supplied, Lavatory faucet. Sloan SL-EL-154 Faucet and Flush Valve Power Kit - For flush valve. Chicago Faucets 131-CFMAB Mixing Valve - Point of use, Tempered water mixer, NSF/ANSI 61 compliant, Integral inlet check valves to protect against cross-flow. McGuire PW155HDWC Fixture Drain - Offset grid drain, Offset drain, Lavatory, Molded Closed cell vinyl (antimicrobial), PVD chrome. McGuire LFH165LKN3 Supply - HEAVY PREMIERE Line Heavy pattern Faucet Supply kit, consisting of (2) stop valves, (2) risers, (2) flanges (standard), Lead Free Chrome-plated finish Brass body, Loose key handle, Angle stop, 305 mm (12") C.P. lavatory flexible copper riser tubes (standard), 10 mm (3/8") I.P.S. inlet x 10 mm (3/8") O.D.. McGuire PW2125WC P-Trap - Molded Closed cell vinyl (anti-microbial) wrapped cast brass, Glossy white, With cleanout.

2.1.10 Kitchen Sink – 1 bowl – CS-1

2.1.11 Franke Commercial UCS6105P-1 Sink - Counter mounted, Single compartment sink, constructed from 18 gauge Type 304 Stainless steel, with overall dimension 578 mm (22-3/4") long, 451 mm (17-3/4") wide, 127 mm (5") high. Delta sink faucet deckmount #26C3233-S8, 8" deck-CER-TECK ceramic structures, heavy duty cast brass sink faucet, tubular swing spout, vandal resistant aerator outlet 5.7 L/min (1.5 GPM), 3: lever blade handles – ADA

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compliant metal colour indexed, vandal resistant screws. Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, mechanical mixing valve. McGuire LFCK165LK Supply - ICV DEFENDER Faucet Supply kit, consisting of (2) stop valves, (2) risers, (2) flanges (standard), Lead Free Chrome-plated finish Brass body, Loose key handle, Angle stop, 305 mm (12") C.P. lavatory flexible copper riser tubes (standard), 10 mm (3/8") I.P.S. inlet x 10 mm (3/8") O.D.. McGuire PW2150WC P-Trap - Molded Closed cell vinyl (anti-microbial) wrapped cast brass, Glossy white, with cleanout.

2.1.12 Kitchen Sink – 2 bowls – CS-2

2.1.13 Franke Commercial UCD6405P-1 Sink - Counter mounted, Double compartment sink, constructed from 18 gauge Type 304 Stainless steel, with overall dimension 785 mm (30-7/8") long, 451 mm (17-3/4") wide, 127 mm (5") high. Delta sink faucet deckmount #26C3233-S8, 8" deck-CER-TECK ceramic structures, heavy duty cast brass sink faucet, tubular swing spout, vandal resistant aerator outlet 5.7 L/min (1.5 GPM), 3: lever blade handles – ADA compliant metal colour indexed, vandal resistant screws. Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, mechanical mixing valve. McGuire LFCK165LK Supply - ICV DEFENDER Faucet Supply kit, consisting of (2) stop valves, (2) risers, (2) flanges (standard), Lead Free Chrome-plated finish Brass body, Loose key handle, Angle stop, 305 mm (12") C.P. lavatory flexible copper riser tubes (standard), 10 mm (3/8") I.P.S. inlet x 10 mm (3/8") O.D.. McGuire PW2150WC P-Trap - Molded Closed cell vinyl (anti-microbial) wrapped cast brass, Glossy white, with cleanout

2.1.14 Janitor Mop Sink Floor Mounted – MS-1

2.1.14.1 Stern Williams #SB-900-T-35-T-40-BP Floor mounted, Single compartment sink, constructed from Precast terrazzo, with overall dimension 610 mm (24") long, 610 mm (24") wide, 305 mm (12") high. Chicago Faucets #305VB-369VP-XK wall mounted two handle manual faucet, 203mm (8") centerset, chrome plated solid brass exposed body, ceramic 1/4 turn cartridges, unrestricted hose end outlet, 140mm (5-1/2") from wall to outlet reach, with body-mounted vacuum breaker, metal red and blue index buttons 60mm (2-3/8") long lever handles with vandal resistant screw. Stern Williams A-20 bumper guard, anodized aluminum cap. Stern Williams T-35 hose and wall hook, hose 914mm (36") long with 20mm (3/4") chrome coupling, stainless steel wall bracket. Stern Williams T-40 mop hanger stainless steel #4 finish, 610mm (24")

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long with 3 rubber spring loaded clips. Stern Williams BP back splash panel 20 gauge type 304 stainless steel. Stern Williams TC-3 gasket 75mm (3") for XHCI, plastic and steel pipe. Provide P-trap, same material as the connecting pipe drain.

- 2.1.15 Combination Eyewash & Shower Safety Station – EES-1
- 2.1.15.1 Guardian G1902-AP275-200-G3800LF-SSH-GC-HS-HFC-AP250-015 Emergency Equipment - Floor mounted, constructed from Stainless Steel Bowl and ABS or Stainless Steel Showerhead, Stainless steel, 283 mm (11-1/8") Ø bowl size, Thermostatic mixing valve blends hot and cold water, finish, Orange ABS plastic showerhead, Two GS-Plus spray heads with flip top dust cover each, Stainless steel showerhead, 254 mm (10") Ø showerhead size, 75 LPM (20 GPM) flow control, Auxiliary Hose Spray, 32 mm (1-1/4") Ø NPT female outlet, Electric Flashing light and alarm horn unit. Lawler 911-Unit 8334 Mixing Valve - Emergency mixing valve, Thermostatic High-low master water mixing valve. Watts FD-460NH-F Floor Drain - Epoxy coated cast iron, Floor drain, Square 324 x 324 mm (12-3/4" x 12-3/4") top, No-hub outlet, Heel proof ductile iron grate.
- 2.1.16 Shower – SH-1
- 2.1.16.1 Symmons Institutional Showerhead # 4-295-A-1.5, showerhead at 30 degree spray anfle with mounting bracket and fasteners, anchor plate for use with ceramic tile, 5.7 L/min (1.5 gpm) flow rate restrictor, vandal resistant, polished chrome finish, solid brass construction. Symmons Showeroff Valve and Trim #4-420, polished chrome finish, manual showeroff limiter valve cartridge, in-line vacuum breaker.
- 2.1.17 Shower – BF – SH-2
- 2.1.17.1 Symmons wall mounted slide and grab bar and ADA hand shower with non-positive shut-off #T736 with 36" slide/grab bar with polished chrome ADA hand shower, 5.7 L/min (1.5 gpm) flow restrictor. Symmons Showeroff Valve and Trim #4-420, polished chrome finish, manual showeroff limiter valve cartridge, in-line vacuum breaker.
- 2.1.18 Indoor Drinking Fountain & Bottle Filling Station – Wall Hung (Barrier Free Design & General Use) – BF-1
- 2.1.18.1 Elkay Enhanced ezH2O #LZS8WSSP bottle filling station & single ADA cooler refrigerated stainless high capacity lead reductions

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quick filter change, chilling capacity to 8.0 GPH antimicrobial, automatic filter status reset, filtered, green ticker, hands free, laminar flow, real drain, Flexi-Guard safety bubbler, electronic bottle filler sensor with electronic front and side bubbler pushbar activation, in-wall carrier #MLP100

2.1.19 Outdoor Drinking Fountain and Bottle Filling Station – BF-2

2.1.19.1 Elkay Outdoor ezH2O #LK4408BF-BLU Bottle filling station wall mount with single fountain, non-filtered, non-refrigerated, heavy duty vandal resistant, laminar flow, 300 stainless steel, furnished with vandal resistant bubbler, mechanical button activation, blue colour. Provide heat trace for pipes. Provide carrier as required.

3 **EXECUTION**

3.1 TRAPS

3.1.1 Provide every fixture with traps in accordance with local regulations. Provide each trap with its own brass plug and ferrule cleanout.

3.1.2 For traps located in ceilings, provide access doors.

3.2 UNIONS, FLANGES

3.2.1 Provide unions or flanges at all connections to fixtures requiring servicing or replacing.

3.2.2 In copper pipes, provide wrought copper unions with soldered joints for pipes up to and including DN50 (2") sizes and 1,034 kPa (150 psi) cast brass flanges for pipes DN100 (4") or larger.

3.3 FIXTURES

3.3.1 Supply and install all hangers, supports, brackets, reinforcement, steel back-up plates, etc. for the proper installation of fixtures and supply fittings.

3.3.2 Install all components in strict accordance with manufacturer's recommendations.

3.3.3 Where plumbing fixtures contact wall, and/or floors, seal joints with Dow Corning #781, building sealant, make watertight and bead smooth in a neat professional manner.

3.3.4 Exposed trim, supplies, traps, fittings, etc. shall be brass, heavily

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chrome plated unless noted otherwise.

- 3.3.5 Provide a trap for each fixture.
- 3.3.6 Vent fixtures in accordance with Section 22 13 16 – Sanitary Waste and Vent Piping.
- 3.3.7 Install chrome plated angle on straightaway type screwdriver compression stops, as required, on all hot and cold water service connections to all fixtures.
- 3.3.8 Install escutcheon plates where all service connections to fixtures pass through walls or floors. Plates shall be cast brass, heavy chrome plated. Same internal diameter as external diameter of pipe.

END OF SECTION

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Equipment	Manufacturer on which the Contract Documents are based	Acceptable Alternate Manufacturers	Further Alternative Manufacturers	Net Cost Difference
Access Doors	• Acudor	<ul style="list-style-type: none"> • Lehage • Zurn • Mifab • Nailor-Hart • Josam • SMS 	_____	- \$ _____
Fire Stopping	• 3M	<ul style="list-style-type: none"> • Hilti • Tremco 	_____	- \$ _____
Hangers	• Taylor	<ul style="list-style-type: none"> • Grinnell • Anvil • Myatt 	_____	- \$ _____
Valve, Pipe and Equipment Identification	• SMS	<ul style="list-style-type: none"> • MagTool • Seton 	_____	- \$ _____
Insulation (glassfiber)	• Knauf	<ul style="list-style-type: none"> • Manson • Johns Manville 	_____	- \$ _____
Insulation (elastomeric closed cell)	• Armaflex	<ul style="list-style-type: none"> • Imcoa 	_____	- \$ _____
Gate & Globe Valves	• Kitz	<ul style="list-style-type: none"> • Toyo • Apollo • Crane • Victaulic • Watts 	_____	- \$ _____
Check Valves	• Kitz	<ul style="list-style-type: none"> • Toyo • Apollo • Jenkins • Duo Check • Mueller • Crane • Check Rite • Moygro • Victaulic 	_____	- \$ _____
Silent Check Valves	• Apco	<ul style="list-style-type: none"> • Smolensky • Mueller • Victaulic 	_____	- \$ _____
Ball Valves	• Kitz	<ul style="list-style-type: none"> • Toyo • Apollo • MAS 	_____	- \$ _____

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Equipment	Manufacturer on which the Contract Documents are based	Acceptable Alternate Manufacturers	Further Alternative Manufacturers	Net Cost Difference
Butterfly Valves	• Kitz	• Jenkins • Toyo • De Zurik • Apollo • Crane • Center Line • Victaulic • MAS	_____	- \$ _____
Circuit Balancing Valves	• Victaulic / TA	• RWV • ITT • Taco • Armstrong Fluid Technology • Oventrop	_____	- \$ _____
Pressure Reducing Valves (Liquid)	• Watts	• Fisher • Conbraco • Singer • Cla-Val • Clayton	_____	- \$ _____
Pressure Reducing Valves (Nat. Gas)	• Fisher	• Clayton • Powers	_____	- \$ _____
Motor Control Centres, Starters	• Square D	• Siemens • Cutler-Hammer • Klockner-Moeller • Westinghouse	_____	- \$ _____
Electric Pipe Tracing	• Raychem	• Chromalox • Ouellet	_____	- \$ _____
Electric Duct Heaters	• Chromalox	• Indeeco • P.M. Wright • Thermolec	_____	- \$ _____
Variable Frequency Drives	• Danfoss	• Siemens • Emerson • ABB	_____	- \$ _____
Chemical Treatment	• Norkem	• Drew • Klensoid • Bird-Archer • GE Betz	_____	- \$ _____
Glycol Products	• Dow	• Interstate	_____	- \$ _____

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Equipment	Manufacturer on which the Contract Documents are based	Acceptable Alternate Manufacturers	Further Alternative Manufacturers	Net Cost Difference
Silencers	<ul style="list-style-type: none"> Kinetics 	<ul style="list-style-type: none"> Vibro-Acoustics E.H.Price 	_____	- \$ _____
Vibration Isolation	<ul style="list-style-type: none"> Mason 	<ul style="list-style-type: none"> Vibro-Acoustics Kinetics 	_____	- \$ _____
Flexible Connections, Expansion Joints	<ul style="list-style-type: none"> Flexpression 	<ul style="list-style-type: none"> US Hose Hyspan Flextech Flex-Hose Flexonics 	_____	- \$ _____
Fuel Oil Tanks	<ul style="list-style-type: none"> Steelcraft 	<ul style="list-style-type: none"> DTE Fulton Drummond 	_____	- \$ _____
Positive Displacement Pump (Oil)	<ul style="list-style-type: none"> Albany 	<ul style="list-style-type: none"> Aurora Canada Pumps Viking 	_____	- \$ _____
Air Compressors	<ul style="list-style-type: none"> Ingersoll-Rand 	<ul style="list-style-type: none"> Broomwade Atlas-Copco DeVilbiss 	_____	- \$ _____
Thermometers and Gauges	<ul style="list-style-type: none"> Treice 	<ul style="list-style-type: none"> Taylor Winters Ashcroft 	_____	- \$ _____
Strainers	<ul style="list-style-type: none"> Armstrong 	<ul style="list-style-type: none"> Streamflo Sarco Gestra Mueller 	_____	- \$ _____
Sidestream Filters	<ul style="list-style-type: none"> Lakos 	<ul style="list-style-type: none"> Bell & Gossett Rosedale 	_____	- \$ _____
Hydro Pneumatic Expansion Tanks	<ul style="list-style-type: none"> Armstrong Fluid Technology 	<ul style="list-style-type: none"> Taco Expanflex Bell & Gossett Clemmer 	_____	- \$ _____
Air Separators	<ul style="list-style-type: none"> Armstrong Fluid Technology 	<ul style="list-style-type: none"> Taco Expanflex Bell & Gossett 	_____	- \$ _____
Pressure Relief Valves	<ul style="list-style-type: none"> Armstrong Fluid Technology 	<ul style="list-style-type: none"> Bell & Gossett Watts 	_____	- \$ _____
Steam Traps	<ul style="list-style-type: none"> Sarco 	<ul style="list-style-type: none"> Armstrong International Gestra 	_____	- \$ _____

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Equipment	Manufacturer on which the Contract Documents are based	Acceptable Alternate Manufacturers	Further Alternative Manufacturers	Net Cost Difference
Steam Pressure Reducing Valves	• Fisher	• Gestra • ITT Hoffman	_____	- \$ _____
Vertical In-Line Pumps	• Armstrong Fluid Technology	• Bell & Gossett • Taco	_____	- \$ _____
Base Mounted Pumps	• Armstrong Fluid Technology	• Bell & Gossett • Taco	_____	- \$ _____
Integrated Pumping Systems	• Armstrong Fluid Technology	• Bell & Gossett • Taco	_____	- \$ _____
In-Line Circulators	• Armstrong Fluid Technology	• Taco • Bell & Gossett	_____	- \$ _____
Condensing Boilers	• Camus	• Raypak • RBI • Viessmann • Aerco • Paterson-Kelly • Lochinvar	_____	- \$ _____
Fire Tube Boiler	• Camus	• Raypak • Lockinvar	_____	- \$ _____
Near Condensing Boiler	• RBI	• Raypak • Paterson-Kelly • De Dietrich	_____	- \$ _____
Boiler/Burner Package (Fire Tube)	• Cleaver-Brooks	• Volcano	_____	- \$ _____
Electric Boilers	• Precision Boilers	• Laars • Lochinvar • Thermo2000	_____	- \$ _____
Breeching and Flues	• Environ/Cheminee	• Van Packer • Selkirk	_____	- \$ _____
Unit Heaters (Gas-Fired)	• Modine	• Engineered Air • Trane	_____	- \$ _____
Centrifugal Chillers	• Daikin	• Trane • York • Carrier	_____	- \$ _____
Water-Cooled Scroll Chiller	• Daikin	• Trane • York • Artic • Carrier	_____	- \$ _____

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Equipment	Manufacturer on which the Contract Documents are based	Acceptable Alternate Manufacturers	Further Alternative Manufacturers	Net Cost Difference
Water-Cooled Screw Chiller	• Daikin	<ul style="list-style-type: none"> • Trane • York • Artic • Carrier 	_____	- \$ _____
Air-Cooled Scroll Chiller	• Daikin	<ul style="list-style-type: none"> • Trane • York • Artic • Carrier 	_____	- \$ _____
Air-Cooled Screw Chiller	• Daikin	<ul style="list-style-type: none"> • Trane • York • Artic • Carrier 	_____	- \$ _____
Air-Cooled Centrifugal Magnetic Bearing Chiller	• Artic	<ul style="list-style-type: none"> • Multistack • Smardt 	_____	- \$ _____
Modular Chiller	• Artic	<ul style="list-style-type: none"> • Multistack • Smardt 	_____	- \$ _____
Heat Recovery Chiller	• Daikin	<ul style="list-style-type: none"> • Trane • York • Artic • Carrier • Smardt • Multistack 	_____	- \$ _____
Cooling Towers (induced/forced draft)	• B.A.C.	<ul style="list-style-type: none"> • Evapco • SPX Marley 	_____	- \$ _____
Evaporative Fluid Coolers	• B.A.C.	<ul style="list-style-type: none"> • Evapco • SPX Marley 	_____	- \$ _____
Split Type A/C Units	• Mitsubishi Electric	<ul style="list-style-type: none"> • Daikin • LG 	_____	- \$ _____
VRF	• Mitsubishi Electric	<ul style="list-style-type: none"> • Daikin • LG 	_____	- \$ _____
Air Coils	• Aerofin	<ul style="list-style-type: none"> • Engineered Air • Trane • Rosemex • Daikin 	_____	- \$ _____
Snow / Ice Melting System	• Rehau	<ul style="list-style-type: none"> • Uponor 	_____	- \$ _____

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Equipment	Manufacturer on which the Contract Documents are based	Acceptable Alternate Manufacturers	Further Alternative Manufacturers	Net Cost Difference
Plate and Frame Heat Exchangers	<ul style="list-style-type: none"> Armstrong Fluid Technology 	<ul style="list-style-type: none"> APV Alfa-Laval Bell & Gossett Taco 	_____	- \$ _____
Shell and Tube Converters	<ul style="list-style-type: none"> Armstrong Fluid Technology 	<ul style="list-style-type: none"> Bell & Gossett Taco 	_____	- \$ _____
Cabinet Unit Heaters	<ul style="list-style-type: none"> Sigma 	<ul style="list-style-type: none"> Engineered Air Trane Rosemex Dunham-Bush Modine Rittling 	_____	- \$ _____
Unit Heaters (Hot water)	<ul style="list-style-type: none"> Sigma 	<ul style="list-style-type: none"> Engineered Air Trane Rosemex Dunham-Bush Modine Rittling 	_____	- \$ _____
Electric Heaters	<ul style="list-style-type: none"> Ouellet. 	<ul style="list-style-type: none"> Indeeco Chromalox 		
Fan Coil Units	<ul style="list-style-type: none"> Daikin 	<ul style="list-style-type: none"> Trane Carrier York International Enviro-Tec 	_____	- \$ _____
Radiation (Steam and Hot Water)	<ul style="list-style-type: none"> Sigma 	<ul style="list-style-type: none"> Engineered Air Trane Rosemex Dunham-Bush Modine Rittling 	_____	- \$ _____
Radiation Enclosures	<ul style="list-style-type: none"> Sigma 	<ul style="list-style-type: none"> Engineered Air Trane Rosemex Dunham-Bush Rittling 	_____	- \$ _____
Fan Forced Heaters (Hot Water)	<ul style="list-style-type: none"> Sigma 	<ul style="list-style-type: none"> Engineered Air Trane Rosemex Dunham-Bush Modine Rittling 	_____	- \$ _____

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Equipment	Manufacturer on which the Contract Documents are based	Acceptable Alternate Manufacturers	Further Alternative Manufacturers	Net Cost Difference
Baseboard Radiant Panels	• Runtal	• Hudevad	_____	- \$ _____
Ceiling Radiant Panels	• Epsilon	• Frenger • Rosemex • Dunham-Bush • Sigma • Twa	_____	- \$ _____
Gas-Fired Humidifiers	• Condair	• Dri-Steem • Engineered Air • Armstrong International	_____	- \$ _____
Electric Humidifiers	• Condair	• Carnes • Dri-Steem • Vapac	_____	- \$ _____
Fogging Humidifier	• Condair	• Enviroair • Armstrong International	_____	- \$ _____
Packaged Outdoor HVAC Units	• Lennox	• Carrier • York • Trane • Rheem	_____	- \$ _____
Air Cooled Condensers	• Rheem	• Trane • York • Carrier	_____	- \$ _____
Water Source Heat Pumps	• Daikin	• York • Carrier • Trane • Omega • Whalen • Aaon	_____	- \$ _____
Vertical Stack Water Source Heat Pumps	• Omega	• Whalen • ClimateMaster	_____	- \$ _____
Semi-Custom Air Handling Units	• Daikin	• Aaon • Engineered Air • Trane	_____	- \$ _____
Custom Air Handling Units	• Haakon	• Ventrol • Engineered Air • Scott • Springfield	_____	- \$ _____
Gas-Fired Make-up Air Units	• Engineered Air	• Aaon • Trane	_____	- \$ _____

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Equipment	Manufacturer on which the Contract Documents are based	Acceptable Alternate Manufacturers	Further Alternative Manufacturers	Net Cost Difference
Compartment Air Handling Units	<ul style="list-style-type: none"> Daikin 	<ul style="list-style-type: none"> Trane Engineered Air Mammoth Carrier 	_____	- \$ _____
Pool Air Handling Unit	<ul style="list-style-type: none"> Seresco 	<ul style="list-style-type: none"> Dectron Poolpak 	_____	- \$ _____
Energy Recovery Ventilator	<ul style="list-style-type: none"> Aldes 	<ul style="list-style-type: none"> Price Vanee Panasonic 	_____	- \$ _____
Computer Room Air Conditioning Units	<ul style="list-style-type: none"> Vertiv 	<ul style="list-style-type: none"> Stulz ecosAire 	_____	- \$ _____
Ecology Unit	<ul style="list-style-type: none"> Halton 	<ul style="list-style-type: none"> Spring Air Systems Carroll 	_____	- \$ _____
Aluminum Propeller Fans	<ul style="list-style-type: none"> Cook 	<ul style="list-style-type: none"> Carnes Greenheck PennBarry Twin City 	_____	- \$ _____
Steel Propeller Fans	<ul style="list-style-type: none"> Cook 	<ul style="list-style-type: none"> Carnes Greenheck PennBarry Twin City 	_____	- \$ _____
Centrifugal Square In-Line Fans	<ul style="list-style-type: none"> Cook 	<ul style="list-style-type: none"> Carnes Acme Greenheck PennBarry Twin City 	_____	- \$ _____
Duct/Ceiling In-Line Fans	<ul style="list-style-type: none"> Cook 	<ul style="list-style-type: none"> Carnes Acme Greenheck PennBarry Twin City 	_____	- \$ _____
Mixed Flow In-Line Blowers	<ul style="list-style-type: none"> Cook 	<ul style="list-style-type: none"> Greenheck Twin City PennBarry 	_____	- \$ _____
Tubular Centrifugal In-Line Fans	<ul style="list-style-type: none"> Cook 	<ul style="list-style-type: none"> Carnes Greenheck PennBarry Twin City 	_____	- \$ _____

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Equipment	Manufacturer on which the Contract Documents are based	Acceptable Alternate Manufacturers	Further Alternative Manufacturers	Net Cost Difference
Vane Axial Fans	• Cook	• Carnes • Greenheck • PennBarry • Twin City	_____	- \$ _____
Double Width Airfoil Centrifugal Blowers	• Cook	• Acme • Greenheck • PennBarry • Twin City	_____	- \$ _____
Plenum Fans	• Cook	• Greenheck • Twin City • PennBarry	_____	- \$ _____
Spun Aluminum Exhaust Fans	• Cook	• Carnes • Acme • Greenheck • PennBarry • Twin City	_____	- \$ _____
Residential Cabinet Exhaust Fans	• Zonex	• Kanalflo • Reversomatic • Twin City • Cook • Carnes • Camfil	_____	- \$ _____
Air Filters	• American Air Filter	• Nailor Ind • Price • Greenheck • Alumavent • Carnes • NCA	_____	- \$ _____
Fire Dampers	• Ruskin	• Titus • Nailor Ind • Krueger • Carnes • Metalaire	_____	- \$ _____
Registers, Grilles and Diffusers	• Price	• Price • Empco • Greenheck • Ventex • NCA • TenPlus	_____	- \$ _____
Louvers	• Construction Specialties			

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Equipment	Manufacturer on which the Contract Documents are based	Acceptable Alternate Manufacturers	Further Alternative Manufacturers	Net Cost Difference
Variable Volume and Fan Powered Boxes	• Price	<ul style="list-style-type: none"> • Titus • Krueger • Nailor Ind. • Carnes • Metalaire 	_____	- \$ _____
CO Monitoring System	• Enmet	<ul style="list-style-type: none"> • Vulcain • Air Test Technologies • Belimo (Opera) 	_____	- \$ _____
Automatic Control Dampers	• Ruskin	<ul style="list-style-type: none"> • Tamco • Greenheck • Price • Alumavent • NCA 	_____	- \$ _____
Automatic Control Valves	• Johnson Controls	<ul style="list-style-type: none"> • Siemens • Belimo • Honeywell 	_____	- \$ _____
Valve and Damper Actuators	• Belimo	<ul style="list-style-type: none"> • Siemens • Johnson Controls • Honeywell 	_____	- \$ _____

END OF SECTION

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Section Name: **Hydronic Valves**
Section No.: **23 05 23**
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Section No.: **23 05 23**
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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide valves for all hydronic piping systems, with the exception of control valves. Control valves shall be supplied under the work of the Division 25 – Integrated Automation Subcontractor, installed under this Section, and connected as part of the work of the Division 25 – Integrated Automation Subcontractor.

1.3 SHOP DRAWINGS

1.3.1 Provide Shop Drawings for:

1.3.1.1 All hydronic valves (except control valves)

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All valves shall be of one manufacture unless otherwise noted in the Contract Documents and should have the manufacturer's name and pressure rating clearly marked on the body. Valves to conform to the current of ANSI, ASTM, ASME, and applicable Manufacturers' Standardization Society Specification (MSS).

2.1.2 Bronze valves up to and including 1034kPa (150 psi) steam pressure shall be manufactured to ASTM B62-93 standard. Bronze valves up to 1379kPa (200 psi) and 2068kPa (300 psi) steam pressure shall be manufactured to ASTM B61-93 standard. Bronze valves used in water systems may be cast bronze to ASTM B584-87 alloy CDA-836.

2.1.3 Iron body valves shall be ductile iron manufactured to ASTM A536-84 Grade 65-45-12 or cast iron ASTM A126-95 Class B standard where ductile iron is not available.

2.1.4 All valves shall have a CRN registration number.

2.1.5 Valve Materials

2.1.5.1 Bronze: to ASTM B62 or B61 as applicable

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- 2.1.5.2 Brass: to ASTM B283 C3770
- 2.1.5.3 Cast Iron: to ASTM A126, Class B
- 2.1.5.4 Forge Steel: to ASTM A105N
- 2.1.5.5 Cast Steel: to ASTM A216WCB
- 2.1.6 Valve Markings
 - 2.1.6.1 All pressure ratings, manufacturers' trademark and size to conform as per MSS-SP-25.
- 2.1.7 End Connections
 - 2.1.7.1 Threaded ends: to ASME B1.20.1
 - 2.1.7.2 Solder ends: to ASME B16.18
 - 2.1.7.3 Flanged ends: to ASME B16.1 (Class 125)
 - 2.1.7.4 Face To Face dimensions: to ASME B16.10
 - 2.1.7.5 Fanged ends: to ASME B16.5
 - 2.1.7.6 Butt Weld Ends: to ASME 16.25
 - 2.1.7.7 Socket Weld Ends: to ASME B.16.11
- 2.1.8 Testing & Design
 - 2.1.8.1 MSS-SP-80 - Bronze, Gate & Check Valves
 - 2.1.8.2 MSS-SP-110 - Ball Valves
 - 2.1.8.3 MSS –SP-70, 85, 71 - Cast Iron Gate, Globe & Check Valve
 - 2.1.8.4 MSS-SP-72 - American Valve
 - 2.1.8.5 MSS-SP-67 - Kitz, Apollo, Toyo, Demco & WKM E, Butterfly Valves
 - 2.1.8.6 API 602 - Forge Steel Valves (Design)
 - 2.1.8.7 API 598 - Cast Steel Valves, Forge Steel Valves (Testing)
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2.1.8.9 API 600 - Cast Steel Valves (Design)

2.2 VALVES FOR LOW PRESSURE SERVICE

2.2.1 This Subsection applies to valves used in heating and chilled water systems, condenser water systems, and chemical feed systems up to 1,034 kPa (150 psi) system operating pressure.

2.2.2 Gate Valves

2.2.2.1 50mm (2") dia. or less - shall be Class 125, all bronze, with solid wedge disc, rising stem.

Threaded ends - Toyo 293
 - Kitz 24
 - Crane 428

Soldered ends - Toyo 299
 - Kitz 44
 - Crane 1334

2.2.2.1.1 For application where non-rising stem is required.

Threaded ends - Toyo 280A
 - Kitz 40
 - Crane 438

Soldered ends - Toyo 281A
 - Kitz 41
 - Crane 1324

2.2.2.2 65mm (2-½") dia. and over - shall be Class 125, iron body/bronze mounted, with O.S. & Y., solid wedge design.

Flanged ends - Toyo 421
 - Kitz 72
 - Jenkins Fig. 454J
 - Crane 465 ½

2.2.2.2.1 For application where non-rising stem is required.

Flanged ends - Toyo 415
 - Kitz 75
 - Jenkins Fig. 452J
 - Crane 461

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2.2.3 Globe Valves

2.2.3.1 50mm (2") dia. or less - shall be Class 125, all bronze, with rising stem, fitted with PTFE disc.

Threaded ends - Toyo 220
- Kitz 03
- Crane 7TF

Soldered ends - Toyo 212
- Kitz 10
- Crane 1310

2.2.3.2 65mm (2-½") dia. and over - shall be Class 125, iron body/bronze mounted, O.S. & Y.

Flanged ends - Toyo 400A
- Kitz 76
- Crane 351

Alternative - Jenkins Fig. 2342J (renewable bronze seat and disc)

2.2.4 Check Valves

2.2.4.1 50mm (2") dia. or less - shall be Class 125, all bronze, Y pattern swing check.

Threaded ends - Toyo 236
- Kitz 22
- Crane 37

Soldered ends - Toyo 237
- Kitz 23
- Crane 1342

2.2.4.1.1 If lift check valve required.

Threaded ends - Kitz 36 (vertical)
- Jenkins Fig. 117ATJ (horizontal)
- Jenkins Fig. 119J (vertical)
- Crane 29 (vertical)
- Crane 27TF (horizontal)

2.2.4.2 65mm (2-½") dia. and over - shall be Class 125, iron body/bronze mounted or stainless steel, with bolted bonnet.

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- Flanged ends
 - Toyo 435A
 - Kitz 78
 - Jenkins Fig. 587J
 - Duo Check II (Wafer style)
 - Mueller 71 series
 - Crane 373
 - Check Rite CET (Wafer Style)
 - Moygro W12A-16V (Wafer Style)
- Grooved ends
 - Victaulic Series 712 (horizontal), 716 (vertical) or 779 with Venturi-taps

2.2.4.2.1 If silent check valve is required - cast iron body, bronze trim, EPDM seat, spring loaded center guided disc, stainless steel spring and shaft.

- Flanged ends
 - Apco or Smolenski
 - Mueller
- Grooved ends
 - Victaulic 716 - 65mm (2-½") to 300mm (12")
 - Victaulic AGS W715 - 350mm (14") to 750mm (30")

2.2.5 Ball Valves

2.2.5.1 50mm (2") dia. or less - shall be rated for 1034kPa (150 psi) steam, 4137kPa (600 psi) non-shock cold water or oil, with full or standard port brass or bronze body, brass chrome plated ball, Teflon seats and packing.

- Threaded ends
 - Toyo 5044A
 - Kitz 58
 - Apollo 77C-100
 - MAS B-3
 - Victaulic Series 722
- Soldered ends
 - Toyo 5049A
 - Kitz 59
 - Apollo 77C-200
 - MAS B-4

2.2.5.2 For hot water heating applications, stainless steel ball and stem.

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- Threaded ends
 - Toyo 5043-S
 - Kitz 58M/68AM-LL
 - Apollo 76F-100
- Soldered ends
 - Toyo 5041S
 - Kitz 59M/69AM-LL

2.2.6 Butterfly Valves

2.2.6.1 65mm (2-½") dia. and up to 300mm (12") dia. - shall be Class 125, cast or ductile iron full lug body with bronze disk, stainless steel stems, EPDM resilient seat, with a 1379kPa (200 psi) single flange shut off rating (dead end service) and 121°C (250°F) temperature rating.

2.2.6.2 Valves 50mm (2") dia. and up to 100mm (4") dia. shall have a 10-position lever. Valves 150mm (6") dia. and above shall have hand wheel gear activator.

- Lug Style
 - Newman Hattersley Fig. 45-31532x
 - Kitz 6122EL/G
 - Toyo 918BESL/G
 - Jenkins Fig. 2232ExJ
 - De Zurik BGM
 - Apollo 143-DBE-11/12
 - Crane 44BXZ
 - Centerline 200 series
 - MAS D-Series LD4AE

2.2.6.3 Grooved end butterfly valves:

2.2.6.3.1 DN50 – DN300 (2" – 12") shall be rated to 2,068 kPa (300 psi) and dead-end service capable to full rated pressure. Body material shall be ductile iron with blow-out proof stainless steel stem, electroless nickel coated ductile iron disc, pressure responsive EPDM seat for water service with temperature range of –34°C to +110°C (-30°F to 230°F). Stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.

- Victaulic Vic-300 MasterSeal.

2.2.6.3.2 DN350 – DN750 (14" – 30") shall be rated to 2,068 kPa (300 psi) and dead-end service capable to full rated pressure. Body material shall be ductile iron with blow-out proof stainless steel stem, PPS (polyphenylene sulfide) coated ductile iron disc, and EPDM seal for water service with temperature range of –34°C to +110°C

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(-30°F to 230°F). Stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.

- Victaulic AGS Series W706
(W709 for services to 1,270 kPa (175 psi))

2.2.7 Plug Valves

2.2.7.1 DN80 (3") dia. or less - shall be Class 125, bronze eccentric plug valve, with memory stop and drip cap, grooved, flanged or screwed ends, as appropriate for piping system.

- DeZurik PEC Series

2.2.7.2 DN100 (4") dia. up to DN300 (12") dia. - shall be Class 125, bronze eccentric plug valve, with handwheel gear, and grooved, flanged or screwed ends, as appropriate for piping system.

- DeZurik PEC Series

- Victaulic Series 377

(grooved ends, rated to 1,270 kPa (175 psi))

2.2.8 Each hydronic terminal unit shall be provided with a 'Dahl' radiator valve, series 121 with soldered connection, on the supply and return lines.

2.3 VALVES FOR MEDIUM PRESSURE SERVICE

2.3.1 This Subsection applies to valves used in heating and chilled water systems, condenser water systems, and chemical feed systems up to 1,724 kPa (250 psi) system operating pressure.

2.3.2 Gate Valves

2.3.2.1 50mm (2") dia. or less - shall be Class 150, all bronze, with solid wedge disc, rising stem.

Threaded ends - Toyo 298
 - Kitz 42
 - Crane 431UB

Soldered ends - Kitz 43
 - Crane 1334

2.3.2.1.1 For application where non-rising stem is required.

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Threaded ends - Toyo 204
 - Kitz 46
 - Crane 437

Soldered ends - Kitz 64
 - Crane 1324

2.3.2.2 65mm (2-½") dia. and over - shall be Class 150, cast carbon steel, with bolted bonnet, O.S. & Y., ½ Stellite trim, graphite packing.

Flanged ends - Bonney Forge 1-11-RF
 - Kitz 150 SCLS
 - Crane 47XUF
 - Beric 101-RF-AA08-H
 - Powell 1503-FC8G

2.3.3 Globe Valves

2.3.3.1 50mm (2") dia. or less - shall be Class 150, all bronze, with rising stem, fitted with PTFE disc.

Threaded ends - Toyo 221
 - Kitz 09
 - Crane 7TF

Soldered ends - Kitz 10
 - Crane 1310

2.3.3.2 65mm (2-½") dia. and over - shall be Class 150, cast carbon steel, with bolted bonnet, O.S. & Y., ½ Stellite trim, graphite packing.

Flanged ends - Bonney Forge 1-31-RF
 - Kitz 150 SCJS
 - Crane 143XU
 - Beric 201-RF-AA08-H
 - Powell 1531-FC8G

2.3.4 Check Valves

2.3.4.1 50mm (2") dia. or less - shall be Class 150, all bronze, Y pattern swing check.

Threaded ends - Toyo 238
 - Kitz 29
 - Crane 137

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Soldered ends - Kitz 30
 - Crane 1342

2.3.4.1.1 If lift check valve required.

Threaded ends - Kitz 36 (vertical)
 - Crane 27TF (horizontal)

2.3.4.2 65mm (2-½") dia. and over - shall be Class 150, cast carbon steel, with bolted cover, ½ Stellite trim, stainless steel inserted flexible graphite gasket. Valve shall be silent check.

Flanged ends - Bonney Forge 1-61-RF
 - Kitz 150 SCOS
 - Centreline 800 series
 - Duo Check II lug type
 - Mueller Series 72
 - Beric 301-RF-AAO8-X
 - Check Rite 210CET (Wafer Style)
 - Powell 1561-FC8G
 - Moygro (Wafer Style)

Grooved ends - Victaulic Series 712 (horizontal), 716 (vertical),
 W715 and 779 with Venturi taps

2.3.5 Ball Valves

2.3.5.1 50mm (2") dia. or less - shall be rated for 1034kPa (150 psi) steam, 4137kPa (600 psi) non-shock cold water or oil, full port brass or bronze body, brass chrome plated ball, Teflon seats and packing.

Threaded ends - Toyo 5044A
 - Kitz 58
 - Apollo 77C-100
 - MAS B3
 - Victaulic Series 722

Soldered ends - Toyo 5049A
 - Kitz 59
 - Apollo 77C-200
 - MAS B4

2.3.5.2 For hot water heating applications, stainless steel ball and stem.

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- Threaded ends
 - Toyo 5043-S
 - Kitz 58M/68AM-LL
 - Apollo 76F-100
- Soldered ends
 - Toyo 5041S
 - Kitz 59M/69AM-LL

2.3.6 Butterfly Valves

2.3.6.1 65mm (2-½") dia. and up to 300mm (12") dia. - shall be Class 150, carbon steel full lug body with stainless steel shaft and disk, RTFE packing and seat, and bi-directional bubble tight shut off to the full ASME rating.

2.3.6.2 Valves 65mm (2-½") dia. and up to 100mm (4") dia. shall have a 10-position lever. Valves 150mm (6") dia. and above shall have hand wheel gear activator.

- Lug Style
 - Flowseal 1LA-121-TTG
 - WKM B5113-02-S02-11-HL/G
 - Bray Series 41-466
 - Powell 1572-QCRTXXXGLV/GXX

2.3.6.3 Grooved end butterfly valves:

2.3.6.3.1 DN50 – DN300 (2" – 12") shall be rated to 2,068 kPa (300 psi) and dead-end service capable to full rated pressure. Body material shall be ductile iron with blow-out proof stainless steel stem, electroless nickel coated ductile iron disc, pressure responsive EPDM seat for water service with temperature range of –34°C to +110°C (-30°F to 230°F). Stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.

- Victaulic Vic-300 MasterSeal.

2.3.6.3.2 DN350 – DN750 (14" – 30") shall be rated to 2,068 kPa (300 psi) and dead-end service capable to full rated pressure. Body material shall be ductile iron with blow-out proof stainless steel stem, PPS (polyphenylene sulfide) coated ductile iron disc, and EPDM seal for water service with temperature range of –34°C to +110°C (-30°F to 230°F). Stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.

- Victaulic AGS Series W706.

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2.4 VALVES FOR HIGH PRESSURE SERVICE

2.4.1 This Subsection applies to valves used in heating and chilled water systems, condenser water systems, and chemical feed systems over 1,724 kPa (250 psi) system operating pressure.

2.4.2 Gate Valves

2.4.2.1 50mm (2") dia. or less - shall be Class 800, forge steel body, with O.S. & Y., bolted bonnet, ½ Stellite trim, graphite packing.

Threaded ends - Bonney Forge HL-11-T
 - Beric 501-TX8A08
 - Powell GA08TA58GB

2.4.2.2 65mm (2-½") dia. and over - shall be Class 300, cast carbon steel, with O.S. & Y., bolted bonnet, ½ Stellite trim, graphite packing.

Flanged ends - Bonney Forge 3-11-RF
 - Kitz 300 SCLS
 - Beric 103-RF-AA08-H
 - Powell 3003-FC8G

2.4.3 Globe Valves

2.4.3.1 50mm (2") dia. or less - shall be Class 800, forge steel body, O.S. & Y., bolted bonnet, ½ Stellite trim, graphite packing.

Threaded ends - Bonney Forge HL-31-T
 - Beric 502-TX8A08
 - Powell GL08TA58GB

2.4.3.2 65mm (2-½") dia. and over - shall be Class 300, cast carbon steel, with O.S. & Y., bolted bonnet, ½ Stellite trim, graphite packing.

Flanged ends - Bonney Forge 3-31-RF
 - Kitz 300 SCJS
 - Beric 203-RF-AA08-H
 - Powell 3031-FC8G

2.4.4 Check Valves

2.4.4.1 50mm (2") dia. or less - shall be swing type Class 800, forge steel body, with bolted bonnet, ½ Stellite trim, and graphite gasket.

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Threaded ends - Bonney Forge HL-61-T
 - Beric 504-TX8A08
 - Powell SW08TA58GB

2.4.4.2 65mm (2-½") dia. and over –shall be Class 300, cast carbon steel, with bolted cover, stainless steel inserted flexible graphite gasket.

Flanged ends - Bonney Forge 3-61-RF
 - Kitz 300 SCOS
 - Beric 303-RF-AA08-X
 - Check Rite Model 210 (Wafer Style)
 - Powell 3061-FC8G
 - Moygro (Wafer Style)

2.4.5 Ball Valves

2.4.5.1 50mm (2") dia. or less - shall be rated for 1034kPa (150 psi) steam, 4137kPa (600 psi) non-shock cold water or oil, full port brass or bronze body, brass chrome plated solid ball, Teflon seats and packing.

Threaded ends - Toyo 5044A
 - Kitz 58
 - Apollo 77C-100
 - MAS B3

Soldered ends - Toyo 5049A
 - Kitz 59
 - Apollo 77C-200
 - MAS B4

2.4.5.2 For hot water heating applications, stainless steel ball and stem.

Threaded ends - Toyo 5043-S
 - Kitz 58M/68AM-LL
 - Apollo 76F-100

Soldered ends - Toyo 5041S
 - Kitz 59M/69AM-LL

2.4.6 Butterfly Valves

2.4.6.1 65mm (2-½") dia. and up to 300mm (12") dia. - shall be Class 300, carbon steel full lug body with stainless steel shaft and disk, RTFE packing and seat, and bi-directional bubble tight shut off to the full ASME rating.

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2.4.6.2 Valves 65mm (2-½") dia. and up to 100mm (4") dia. shall have a 10-position lever. Valves 150mm (6") dia. and above shall have hand wheel gear activator.

Lug Style - WKM B5313-02-S02-11-HL/G
- Bray Series 43-466
- Powell 3072-QCRTXXXGLV/GXX

2.4.6.3 Grooved end butterfly valves:

2.4.6.3.1 DN50 – DN300 (2" – 12") shall be rated to 2,068 kPa (300 psi) and dead-end service capable to full rated pressure. Body material shall be ductile iron with blow-out proof stainless steel stem, electroless nickel coated ductile iron disc, pressure responsive EPDM seat for water service with temperature range of –34°C to +110°C (-30°F to 230°F). Stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.

- Victaulic Vic-300 MasterSeal.

2.4.6.3.2 DN350 – DN750 (14" – 30") shall be rated to 2,068 kPa (300 psi) and dead-end service capable to full rated pressure. Body material shall be ductile iron with blow-out proof stainless steel stem, PPS (polyphenylene sulfide) coated ductile iron disc, and EPDM seal for water service with temperature range of –34°C to +110°C (-30°F to 230°F). Stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.

- Victaulic AGS Series W706.

2.5 CIRCUIT BALANCING VALVES

2.5.1 Valve body shall be ductile iron with grooved, flanged, or screwed ends, as appropriate for piping system.

2.5.2 Valves shall have metering ports incorporating EPT check valves on both sides of the seat.

2.5.3 Valves shall be "Y" pattern modified equal percentage globe. Each valve shall be capable of precise flow measurement and positive shut-off.

2.5.4 Valves shall have minimum of four full 360° adjustment turns of the handwheel with a micrometer type indicator and a tamper-resistant memory.

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- 2.5.5 Valve components shall be suitable for intended application.
- 2.5.6 Provide a computerized digital flow meter for future use by the Owner. Meter shall be preprogrammed with circuit setter calibration curves, and be capable of:
 - 2.5.6.1 Direct flow readout
 - 2.5.6.2 Proportional balancing
 - 2.5.6.3 Computing required valve setting
 - 2.5.6.4 Differential pressure measurement
 - 2.5.6.5 Temperature measurement
 - 2.5.6.6 Airflow measurement
 - 2.5.6.7 Leak testing
- 2.5.7 The flow meter shall have automatic calibration and air purging, and be complete with hard lockable case, hoses, fittings, temperature probe, 0 – 18m w.g. (0 – 60 ft w.g.) transducer, and quick connect connections.
- 2.5.8 Select circuit balancing valve size to give a pressure drop at 100% open between 3.0 kPa (0.43 psi) and 21 kPa (3.0 psi). Select valves located remote from the pumps in the circuit near minimum pressure drop, and those located near the pumps at higher pressure drop.
- 2.5.9 Provide preformed rigid insulation for valves.
- 2.5.10 DN50 (2") and smaller: Victaulic / TA Hydronics Series 786 STAS or 787 STAD, RWV 9517 (NPT) / 9519 (soldered)
- 2.5.11 DN 65 (2-1/2") and larger: Victaulic / TA Hydronics Series 788 STAF or 789 STAG, RWV 9574P
- 2.5.12 Terminal Unit Coil Connection Kits
 - 2.5.12.1 At Contractor's option and as detailed in schematics, terminal unit coil kits may be used in lieu of traditional coil installation. Victaulic Series 799 / 79V Koil-Kit Coil Pack shall include the following components: 78Y strainer / ball valve combination (or 78T where strainer is not required), two optional coil hoses, Series 78U union port and a balancing valve (series 78K or TA series 786/787) sized

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to flow rate.

3 **EXECUTION**

3.1 GENERAL

- 3.1.1 Valves shall be the same size as the line in which installed.
- 3.1.2 Valves shall be located in such a manner that the top works, operators, and bonnets may be easily removed.
- 3.1.3 Stems of valves shall be positioned for maximum ease in use, but in no event in a manner causing a hazard, or with stem down unless specifically shown as such.
- 3.1.4 Provide valves where shown on the Drawings, or on schematic diagrams, or in details, or as specified in the Contract Documents.
- 3.1.5 Provide drain valves at all low points of system. Drain valves shall be ball or gate valve with cap and chain.
- 3.1.6 Provide chain wheel operators and operating chain for all valves located more than 2.1m (7 ft) above floor or walkway. Provide chain of sufficient length to extend to within 2.1m (7 ft) of operating platform or floor for free hanging chains, or to within 1.5m (5 ft) of floor in locations where chain can be secured to a wall or column. Provide wall hook as required for securing chain to wall or column.

3.2 GATE AND BUTTERFLY VALVES

- 3.2.1 Provide gate and/or butterfly valves:
 - 3.2.1.1 Where indicated on the Drawings and in the Specification.
 - 3.2.1.2 Entering and leaving all equipment and terminal units.
 - 3.2.1.3 On all branches.
 - 3.2.1.4 As isolation of each floor for all services.
 - 3.2.1.5 At the base of all risers.

3.3 GLOBE VALVES

- 3.3.1 Provide globe valves:
 - 3.3.1.1 Where indicated on the Drawings and in the Specification.

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3.3.1.2 On all bypass systems.

3.3.1.3 Where required for throttling control.

3.4 BALL VALVES

3.4.1 Provide ball valves where indicated on the Drawings and in the Specification.

3.4.2 For pipe sizes DN50 (2") and smaller, ball valves may be substituted for gate and globe valves.

3.5 CHECK VALVES

3.5.1 Provide check valves:

3.5.1.1 Where indicated on the Drawings and in the Specification.

3.5.1.2 On the discharge of all pumps (silent check).

3.5.1.3 On the discharge of multiple equipment.

3.6 RADIATION VALVES

3.6.1 Provide radiation valves on the supply and return lines at each radiation heating element.

3.7 DRAIN VALVES

3.7.1 Install 20mm (¾") dia. drain valves at all down-fed terminal heating and/or cooling units.

3.7.2 Install 40mm (1-½") dia. or line size valves at low points and other drain points on system.

3.7.3 Install 40mm (1-½") dia. valves for flushing purposes.

3.8 CIRCUIT BALANCING VALVES

3.8.1 Provide ball, globe, or eccentric plug valves for throttling or controlling flow where indicated on the Drawings and in the Specification except where circuit balancing valves are specified.

3.8.1.1 Provide ball, globe, or eccentric plug valves in return piping connections to radiators, forced flow heaters, unit heaters, and wallfin heaters.

3.8.2 Provide circuit balancing valves as follows:

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- 3.8.2.1 Where indicated on the Drawings and in the Specification.
- 3.8.2.2 In return branch mains and branch connections to return mains.
- 3.8.2.3 In each return riser.
- 3.8.2.4 In return piping connections to air handling unit heating and cooling coils, fan coil units, heat pump units, reheat coils in air terminal control units, and any other equipment not listed under Paragraph 3.8.1.1.
- 3.8.3 Do not locate handwheel or measuring ports facing downward (to prevent build-up of sedimentation).
- 3.8.4 Position handwheel scale and ports for easy access.
- 3.8.5 Locate balancing valves a minimum of five pipe diameters downstream of any piping, and a minimum of ten pipe diameters from any pump. Maintain two pipe diameters downstream of any balancing valves free of any fitting.
- 3.8.6 Insulate balancing valves with preformed insulation provided by valve manufacturer.
- 3.8.7 Calibrated balancing valves and automatic flow-control valves shall not be used on equipment where pressure independent control valves are installed.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide an electrical pipe tracing system as indicated on the Drawings and specified in this Section.

1.2.2 Connect heat trace power supply from disconnect switches provided under Division 26 - Electrical. Refer to Division 26 – Electrical Drawings for exact locations. Co-ordinate power requirements with Division 26 – Electrical. Refer to Section 20 05 14 – Electrical Wiring for wiring requirements.

1.2.3 Provide electric tracing for the following services:

1.2.3.1 Piping exposed on roof.

1.2.3.2 All heating water lines in unheated areas, except glycol heating system.

1.3 SHOP DRAWINGS

1.3.1 Provide shop drawings for:

- heat trace cables
- temperature controls and ancillaries
- accessories including banding.

1.4 ELECTRICAL EQUIPMENT AND WORKS

1.4.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 – Electrical.

1.4.2 The entire design and installation shall comply with the Ontario Electrical Safety Code and all applicable regulations. Heating cable circuits shall be protected by a ground-fault device for equipment protection. This requirement is in accordance with section 427-22 of the NEC-1996. Ground-fault protection is included with the control system specified for all applications.

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2 PRODUCTS

2.1 GENERAL

2.1.1 Furnish and install a complete cUL Listed, CSA Certified, or FM approved system of heating cables, components, and controls to provide freeze protection of piping as indicated in the Contract Documents.

2.2 PIPE FREEZE PROTECTION CABLES

2.2.1 The self-regulating heating cable shall consist of two (2) 16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field. The heating cable shall be covered by a radiation-crosslinked, modified polyolefin dielectric jacket. To provide a ground path and to enhance the heating cable's ruggedness, the heating cable shall have a braid of tinned copper and an outer jacket of modified polyolefin (-CR), as required per section 427-23 of the NEC-1996. For installation on plastic piping, the heating cable shall be applied using aluminum tape (AT-180). The heating cable shall be Tyco Thermal Controls, XL-Trace series, or approved equivalent.

2.2.2 In order to conserve energy and to prevent overheating, the heating cable shall have a self-regulating factor of at least 90 %. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 4.4°C (40°F) pipe temperature operation to 65.6°C (150°F) pipe temperature operation.

2.2.3 The heating cable shall operate on line voltage of 120 Volts without the use of transformers.

2.2.4 The heating cable for metal-pipe freeze protection shall be sized according to the table below. The required heating cable output rating is in Watts per meter (foot) at 10°C (50°F). (Heating cable selection is based on 50mm (2 inch) fiberglass insulation on metal piping.)

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Pipe size mm (inches)	Minimum Ambient Temperature	
	-17.8°C (0°F)	-28.9°C (-20°F)
100 (4") or less	16.4 (5) Watts	16.4 (5) Watts
150 (6")	16.4 (5) Watts	26.2 (8) Watts
200 (8")	16.4 (5) Watts	26.2 (8) Watts
250 (10") or more	16.4 (5) Watts	2 strips of 16.4 (5) Watts

2.2.5 Power connection, end seal, splice, and tee kit components shall be cUL Listed, CSA Certified, or FM Approved for use as part of the system to provide pipe freeze protection. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. Installation shall not require the installing Subcontractor to cut into the heating-cable core to expose the bus wires. All components that make an electrical connection shall be re-enterable for servicing. Installation of power-connection kits shall be part of the work of Division 23 - HVAC.

2.2.6 No component shall use silicone to seal the electrical connections. An exception will be made in areas where a conduit transition is required.

2.3 TEMPERATURE AND MOISTURE SENSORS

2.3.1 Hydronic chilled and condensate water piping shall have one sensor per circuit pipe-mounted and shall also reference local ambient-temperature sensors for Proportional Ambient Sensing Control.

2.3.2 Temperature sensors shall be 100-ohm platinum RTD (Resistance Temperature Devices), with 3m tails mechanically protected by a corrugated steel sheath and ½" gland fitting for connection to the junction box. Digit race RTD10CS or approved equivalent. Temperature sensors shall be connected to the control system terminals as indicated on heat-tracing schedules. Coordinate conduit and low-voltage signal wiring with Division 16 – Electrical Subcontractor. RTD wiring shall be shielded 3-conductor, 22AWG + drain, Belden type 8771 or approved equivalent.

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2.4 CONTROL SYSTEM

2.4.1 DDC Control System

2.4.1.1 All sensors shall communicate with a DDC system, Digit race ACCS-30 or approved equivalent. This approach serves to minimize the number of sensing devices required for efficient system operation and also to eliminate field-location of control devices and thus reduce the risk of tampering.

2.4.1.2 The Heating Cable manufacturer shall provide a DDC system with pre-programmed parameters to concurrently control and monitor heating cable circuits fire-protection pipe freeze protection. All system programming shall be through a CSA-listed central User Interface Terminal, Tyco Thermal Controls type ACCS-UIT2 or approved equivalent.

2.4.1.3 Heating Cable circuits and sensor signals (refer to Subsection 2.5 above) shall be connected to cUL-listed remote Power Control Modules, Tyco Thermal Controls type ACCS-PCM2-5 or approved equivalent. The Power Control Modules shall each house five two-pole contactors rated to 30A/277V, and five sensor inputs. Power Control Modules shall also include ground-fault sensing devices for each heating cable circuit, the status of which shall be monitored by the control system.

2.4.1.4 Power Control Modules and User Interface Terminal shall be interconnected using RS-485 communication series. Coordinate communication conduit requirements with Division 26 - Electrical.

2.4.1.5 The Control System shall be capable of communicating ground fault, temperature alarms, and status alarms through programmable alarm contacts. In accordance with NFPA13, all Wet Sprinkler heat tracing circuit alarms shall be programmed to a specific terminal for remote notification at the fire alarm panel. Coordinate with Division 26 - Electrical.

2.4.1.6 The Control System shall be capable of communicating operating status, power consumption, and alarms to the Building Automation System in BACnet protocol.

2.4.2 No heat tracing circuit shall extend more than 600mm (24") beyond a point where such junctions permit optional flow paths. In such cases, separately controlled tracers shall be used.

2.4.3 Separately controlled heating circuits shall be provided on dead end legs and closed bypasses.

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2.4.4 Where the rating of the thermostat would be exceeded, it shall be used in conjunction with a relay or contactor.

3 **EXECUTION**

3.1 PIPE FREEZE PROTECTION

3.1.1 Hydrostatically test all piping prior to installation of tracing cables.

3.1.2 Heating Cable Installation shall comply with manufacturer's recommendations.

3.1.3 The cable shall be fastened to metallic piping at intervals no more than 300mm (12") using heat-resistant fiberglass tape, type GT-66 or approved equivalent. Metallic tie-wraps shall not be acceptable as they may puncture the heating cable jacket. When installing on polymer-based piping, aluminum heat-transfer tape shall be installed along the entire length of heating cable to improve performance.

3.1.4 Extra cable shall be used at points such as valves and flanges to compensate for increased heat loss.

3.1.5 All terminations shall be protected from the weather and from physical damage.

3.1.6 Any field alternations or deviations shall proceed only after authority via signed change order has been issued by the Consultant. All changes shall be accurately recorded by the Contractor and shall be turned over to the Consultant upon completion of the work.

3.1.7 Junction boxes, thermostats, and the like shall not be attached to the insulation, but shall be mounted on brackets fabricated of galvanized angle, channel or other material of sufficient strength to support equipment mounted on them.

3.1.8 Apply "Electric Traced" labels to the outside of the thermal insulation, on alternating sides at 3m intervals.

3.2 SENSORS

3.2.1 Install all sensing devices in accordance with manufacturer's recommendations. Refer to notes in Subsection 2.3 above.

3.2.2 Temperature sensors installed on piping (for Line-Sensing) shall be located opposite the heating cable so as to sense the coldest

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temperature on the segment of pipe.

- 3.2.3 Temperature sensors installed in air (for Ambient-Sensing) shall be strapped to the ceiling in a location such that the temperature is representative of the exposure temperature of any associated heat-tracing. Ambient temperature sensors shall not be installed adjacent to exhaust vents.

3.3 CONTROL SYSTEM

- 3.3.1 Install all control components in accordance with manufacturer's recommendations.
- 3.3.2 Sensor signal wiring shall be connected to the appropriate terminal within the appropriate power control module.
- 3.3.3 Control system components shall all be connected in series, using RS-485 twisted pair communication wiring. Coordinate necessary communication conduit runs with Division 26 - Electrical.

3.4 TESTING, COMMISSIONING AND REPORTING

- 3.4.1 All Self-Regulating Cables (for pipe tracing) shall be tested for insulation resistance using a megohmmeter at 500, 1000, and 2500VDC and results shall exceed 1000MΩ to be acceptable. Self-Regulating cables shall also be tested for capacitance to verify continuous circuit lengths, with results recorded in nF and in approximate corresponding length. Refer to manufacturer's installation guides for nF/ft conversion rates for each type of cable.
- 3.4.2 Sensors and Control System shall be concurrently tested and commissioned with the assistance of the manufacturer. Temperature sensors may be tested by observing readings and comparing with actual temperature. Moisture sensors shall be tested by simulating activation criteria (low temperature and moisture) and observing contact engagement.
- 3.4.3 The Division 23 – HVAC Subcontractor is responsible for carrying testing, programming and commissioning costs as part of this Contract.

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
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3.1	Motor Starters

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All motor starters for mechanical equipment.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for:

1.3.1.1 All motor starters.

1.4 ELECTRICAL EQUIPMENT AND WORK

1.4.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 – Electrical.

2 **PRODUCTS**

2.1 MOTOR STARTERS

2.1.1 Provide where indicated, shown on the Motor Starter Schedules and as specified in this Section separate motor starters not forming part of a motor control centre for all mechanical equipment (except those equipped with packaged starters).

2.1.2 Motor starters shall be supplied by the manufacturer of the motor control centres specified, and shall meet the requirements therein complete with disconnect switch, fuses, control transformer, and all auxiliary devices.

2.1.3 Provide combination type with non-fused disconnect switch for individual motor starters equal to CGE CR 208, where overcurrent protection has been provided at motor control centre or distribution source.

2.1.4 Provide combination type with fusible disconnect switches equal to

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CGE CR 208 for grouped motor starters supplied from a common feeder or splitter. Include all interconnection power wiring.

2.1.5 Manual starters for single phase fractional horsepower motors unless otherwise indicated shall be equal to CGE CR 1061 with pilot light in cover. In finished areas, provide flush mounted units with stainless steel covers and pilot lights.

2.1.6 Where starters are grouped, provide a common backboard, interlocking and control wiring indicated on the Motor Starter Schedules and engraved nameplates indicating source of control supply if separate from the starter.

3 **EXECUTION**

3.1 MOTOR STARTERS

3.1.1 Provide lamacoid plastic plates identifying all starters. Provide warning label for motors under remote control. Adhere to Section 20 05 53 – Identification colour scheme for tags.

END OF SECTION



Standard Building Automation System (BAS) Owner Requirements

November, 2019

Version & revision number: 6.1.5

This document is the standard for use in new construction, retrofits and upgrades in City of Toronto facilities and shall not be amended in any way without written consent from the Corporate Real Estate Management (CREM) Division.

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This section includes the central building automation system components and network protocol specifications. It may be used as section 23 09 23 or 23 09 93 depending on specification format used.

In addition to this section it will be necessary to add project specific sections for control components and sequences of operation.

The intent of this specification is to describe the minimum features required for a new installation. For renovation or refit type projects, it will be necessary to determine to what extent any existing system can be upgraded or modified within the parameters of the project budget to achieve the general intent of this specification and provide appropriate edits.

PART 1 - GENERAL

1.0 GENERAL REQUIREMENTS

- 1.1 Conform to all, "Mechanical General Provisions".
- 1.2 The "provide" in this Division shall be interpreted as "supply and install".
- 1.3 All work shall conform to Canadian Metric Practice Guide CSA CAN3-2234.1.76
- 1.4 Provide all required adapters between metric and imperial components.
- 1.5 Metric descriptions in this Division are nominal equivalents of Imperial values.
- 1.6 All equipment and material to be new, CSA certified, manufactured to minimum standard quoted including additional specified requirements.
- 1.7 Where there is no alternative to supply equipment that is not CSA certified, submit such equipment to Inspection Authorities for special inspection and obtain approval before delivery of equipment to site.
- 1.8 Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by the owner. Spare parts shall be available for at least five years after completion of this contract.
- 1.9 Use material and equipment available from a regular production by manufacturer concerned.

2.0 WORK INCLUDED

Add to this section any site specific qualifications that may apply to the specific project with respect to application of the specified requirements for the system.

- 2.1 The City of Toronto has standardized Building Automation Systems utilizing native BACnet area, system and application controllers. Extend the existing Framework as detailed herein.
- 2.2 The system shall support standard Web browser access via the City's Intranet/Internet. It shall support a minimum of 100 simultaneous users with the ability to access the graphical data and real time values simultaneously. (Refer to Section 7.16)
- 2.3 Provide an open protocol Building Automation System (BAS) incorporating Direct Digital Control (DDC), equipment monitoring, and control consisting of: A PC based Operator Work Station (OWS) with colour graphic data displays; Microcomputer based Building Controllers (BCs) and Microcomputer based Advanced Application Controllers (AACs) and Application Specific Controllers (ASCs) interfacing **directly** with sensors,

actuators and environmental delivery systems (i.e., HVAC units, boilers, chillers, lighting systems, etc.); electric controls and mechanical devices for all items indicated on drawings described herein including dampers, valves, panels and compressed air plant.

- 2.4 City of Toronto has standardized the use of Direct Digital Controllers (DDC) and End Devices. No **NEW** pneumatic control devices shall be connected or incorporated into the BAS network. It applies to new installations as well as retrofit applications.
- 2.5 Open Protocols by definition are to be BACnet (ASHRAE Standard 135 – Annex J) and Haystack only.
- 2.6 Provide BAS controllers (BCs, AACs and ASCs) based on native BACnet (ASHRAE Standard 135 – Annex J) protocols.
- 2.7 Provide submittals, data entry, electrical installation, programming, startup, test and validation acceptance documentation, and system warranty.

3.0 WORK BY OTHERS

- 3.1 Access doors and setting in place of valves, flow meters, water pressure and differential taps, flow switches, thermal wells, dampers, air flow stations, and current transformers shall be by others.

4.0 QUALITY ASSURANCE

4.1 Codes and Approvals:

- 4.1.1 Work, materials, and equipment shall comply with the Ontario Building Code, Ontario Electrical Code, ANSI/ASHRAE 135-2004: Data Communication Protocol for Building Automation and Control Systems (BACnet) and Authorities having jurisdiction over this work. All devices shall be ULC, UL or FM listed and labeled for the specific use, application and environment to which they are applied.
 - 4.1.2 The BAS shall comply with NFPA 90A Air Conditioning and 90B Warm Air Heating, Air Conditioning.
 - 4.1.3 All electronic equipment shall conform to the requirements of CSA for electromagnetic emissions standards and placed in approved locations such that it does not interfere with building equipment or computers.
- 4.2 Provide satisfactory operation without damage at 110% above and 85% below rated voltage and at 3 hertz variation in line frequency. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be AC coupled, or equivalent so that any single device failure will not disrupt or halt bus communication.

5.0 ABBREVIATIONS AND SYMBOLS

- 5.1 All letter symbols and engineering unit abbreviations utilized in information displays ANSI/ISA S5.5 and printouts shall conform to ANSI 710.19/IEEE 260-letter symbols for SI and certain other units of measurement.
- 5.2 Specification Nomenclature - Acronyms used in this specification are as follows:

AAC	Advanced Application Controller
ASC	Application Specific Controller
BAS	Building Automation System
BC	Building Controller

BIBB	BACnet Interoperability Building Blocks
DDC	Direct Digital Controls
GUI	Graphical User Interface
HTTP	Hyper Text Transfer Protocol
LAN	Local Area Network
ODBC	Open Database Connectivity protocol
OOT	Object Oriented Technology
OPC	Object linking and embedding for Process Control
OVS	Operator Workstation
PDA	Personnel Data Assistant device
PICS	Protocol Implementation Conformance Statement
PWS	Portable Workstation
SNVTS	Standard Network Variables Types
SQL	Standard Query Language
TCP/IP	Transmission Control Protocol / Internet Protocol
TCU	Terminal Control Unit
WAN	Wide Area Network
WAP	Wireless Application Protocol device
WBI	Web Browser Interface
XML	Extensible Markup Language
XIF	External Interface Files

6.0 APPROVED CONTROL SYSTEMS

Applicable to new construction projects, new installations within existing buildings and major retrofit/overhaul of existing BAS systems.

6.1 Any vendors that are authorized dealers or distributors of the following control systems are acceptable:

- 6.1.1 Delta Controls
- 6.1.2 Reliable Controls
- 6.1.3 Schneider Electric SmartX series
- 6.1.4 Distech Controls
- 6.1.5 Johnson Controls Facility Explorer
- 6.1.6 Honeywell CIPer series, Spyder models 5 or 7

6.2 BAS Systems Integration:

- 6.2.1 All control systems must be integrated to the City's J2 Innovations Fluid Integration (FIN) server, including but not limited to the following:
 - 6.2.1.1 graphical user interface (monitoring & control)
 - 6.2.1.2 alarming
 - 6.2.1.3 data trending
 - 6.2.1.4 data archiving
 - 6.2.1.5 Project Haystack naming convention
- 6.2.2 The installer must be licensed by J2 Innovations to sell, install, program and configure Fluid INtegration (FIN).
- 6.2.3 Building Controllers (BC) must be Tridium Niagara JACE with the Haystack module and driver. The installer must be a licensed Tridium system integrator for any Tridium BCs or embedded or edge Niagara Framework products used. Soft JACE is not accepted.

6.3 Licensing Requirements

- 6.3.1 Licenses shall be provided to and in the name of the City of Toronto
- 6.3.2 Licenses shall be perpetual, transferrable, assignable and royalty-free

- 6.3.3 Tridium licenses shall allow all Workbench/Supervisor brands complete system access and functionality.

6.4 Installer and Manufacturer Qualifications

- 6.4.1 Installer shall have an established working relationship with Control System Manufacturer.
- 6.4.2 Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.
- 6.4.3 It is the intent of this specification to define an open protocol state-of-the-art distributed computerized Building Management and Control System which is user friendly, has known reliability, is extremely responsive, and which is to be designed, installed, implemented, and supported by a local office of approved bidders.
- 6.4.4 BAS contractor shall provide three locations of successful installations of similar open protocol computer based systems. Sites provided must consist of more than 150 hardware inputs/outputs. Project sites must be local to the location of this project.

6.5 System Administration

- 6.5.1 Administrator credentials shall be sent to BAS@Toronto.ca for retention by the City. Credentials shall include any and all accounts and passwords required for complete system access, including but not limited to Station and Platform credentials.

7.0 SYSTEM DESIGN

For retrofit projects where a gateway might be considered the most appropriate economic decision for interface to an existing automation system, remove article 7.2.

- 7.1 The system shall consist of a network of Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), and Smart Actuators (SA). Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.
- 7.2 Systems utilizing gateways will not be considered. A gateway device is considered to be a device where only mapping of system points from one protocol to another occurs. A gateway device cannot perform higher-level energy management functions such as Outdoor Air Optimization, Electrical Demand Limiting and the like.
- 7.3 The Building Automation System software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a BAS server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.
- 7.4 A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a flat single tiered architecture shall not be acceptable. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

8.0 BACnet.

- 8.1 Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
- 8.2 Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
- 8.3 Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
- 8.4 Smart Actuators (SAs). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.
- 8.5 Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.

8.6 BACnet Communication.

- 8.6.1 Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
- 8.6.2 BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
- 8.6.3 Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.
- 8.6.4 Each ASC shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.
- 8.6.5 Each SA shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.
- 8.6.6 Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
- 8.6.7 The maximum number of controllers on an MS/TP network/subnet shall be no more than 64 or the manufacturer recommended limit, whichever is less.
- 8.6.8 An approved addressing scheme must be obtained from BAS@Toronto.ca and be included on project shop drawings (specifically the BAS network architecture diagrams) prior to installation. Buildings without approved schemes shall not exist on the City WAN.
- 8.6.9 BAS shall transfer data between controllers on a stand-alone BAS network. One (1) data drop per building will be provided to establish connection to central server. Should back end programming and configuration be inaccessible via this one (1) data drop, an additional data drop will be provided to allow City BAS Team to communicate to the base building control system using manufacturer software tools.
- 8.6.10 Access to City central servers will not be provided during construction. Database and graphics are merged with central server after project deficiency lists have been cleared (including graphics deficiencies). This merging must be coordinated with the application

- 8.6.11 The City Ethernet connection shall be fully segregated and isolated from the BAS LAN via the secondary BC Ethernet port. A City static IP address will be provided by Technical Services Division (TSD) for this connection. The City's divisional project manager or designate will coordinate this request.

9.0 COMMUNICATION

- 9.1 Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
- 9.2 Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
- 9.3 Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
- 9.4 Stand-Alone Operation. Each piece of equipment specified in the sequence of operation shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

10.0 ENVIRONMENT

Controller hardware shall be suitable for anticipated ambient conditions.

- 10.1 Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
- 10.2 Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

11.0 REAL-TIME CLOCK

- 11.1 Controllers that perform scheduling shall have a real-time clock.

12.0 SERVICEABILITY

- 12.1 Controllers shall have diagnostic LEDs for power, communication, and processor.
- 12.2 Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
- 12.3 Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

13.0 MEMORY

- 13.1 Controller memory shall support operating system, database, and programming requirements.

- 13.2 Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
- 13.3 Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.

14.0 IMMUNITY TO POWER AND NOISE

- 14.1 Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

15.0 POWERFAIL RESTART

- 15.1 In the event of the loss of normal power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
- 15.2 Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention. The controllers shall incorporate random start sequences to ensure a power spike does not result.
- 15.3 Controller memory shall not be lost during a power failure.
- 15.4 The user shall have the capability of loading or re-loading all software via the OWS or the local terminal port.

16.0 DYNAMIC DATA ACCESS

- 16.1 All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment.

17.0 INPUT AND OUTPUT INTERFACE

- 17.1 General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.
- 17.2 Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.
- 17.3 Binary Inputs. Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
- 17.4 Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.
- 17.5 Analog Inputs. Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- 17.6 Binary Outputs. Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- 17.7 Analog Outputs. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
- 17.8 Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
- 17.9 Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

18.0 POWER SUPPLIES AND LINE FILTERING

- 18.1 Power Supplies: Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with CEC requirements. Limit connected loads to 80% of rated capacity.
- 18.1.1 DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes.

Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.

18.1.2 Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.

18.1.3 Line voltage units shall be UL recognized and CSA listed.

18.2 Power Line Filtering.

18.2.1 Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:

18.2.1.1 Dielectric strength of 1000 V minimum

18.2.1.2 Response time of 10 nanoseconds or less

18.2.1.3 Transverse mode noise attenuation of 65 dB or greater

18.2.1.4 Common mode noise attenuation of 150 dB or greater at 40-100 Hz

19.0 AUXILIARY CONTROL DEVICES

19.1 Electric Damper and Valve Actuators.

19.1.1 Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.

19.1.2 Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).

19.1.3 Signal and Range. Proportional actuators shall accept a 0-10 Vdc or a 0-20 mA control signal and shall have a 2-10 Vdc or 4-20 mA operating range. (Floating motor actuators may be substituted for proportional actuators in terminal unit applications as described in paragraph 16.8)

19.1.4 Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.

19.1.5 Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 7 N·m (60 in.-lb) torque capacity shall have a manual crank.

19.2 Binary Temperature Devices.

19.2.1 Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

19.2.2 Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

- 19.2.3 Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 6 m (20 ft) long. Element shall sense temperature in each 30 cm (1 ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.
- 19.3 Temperature Sensors
 - 19.3.1 Type. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor (10K).
 - 19.3.2 Duct Sensors. Duct sensors shall be single point or averaging. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m² (10 ft²) of duct cross-section.
 - 19.3.3 Immersion Sensors. Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
 - 19.3.4 Space Sensors. Space sensors shall have setpoint adjustment, override switch, display, and communication port.
 - 19.3.5 Differential Sensors. Provide matched sensors for differential temperature measurement.
- 19.4 Humidity Sensors.
 - 19.4.1 Differential Sensors. Provide matched sensors for differential temperature measurement.
 - 19.4.2 Duct and room sensors shall have a sensing range of 20%-80%.
 - 19.4.3 Duct sensors shall have a sampling chamber.
 - 19.4.4 Outdoor air humidity sensors shall have a sensing range of 20%-95% RH and shall be suitable for ambient conditions of 40°C-75°C (40°F-170°F).
 - 19.4.5 Humidity sensors shall not drift more than 1% of full scale annually.
- 19.5 Flow Switches. Flow-proving switches shall be paddle (water service only) or differential pressure type (air or water service). Switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).
 - 19.5.1 Paddle switches shall have adjustable sensitivity and NEMA 1 enclosure unless otherwise specified.
 - 19.5.2 Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.
- 19.6 Relays.
 - 19.6.1 Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
 - 19.6.2 Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable $\pm 100\%$ from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.
- 19.7 Override Timers.
 - 19.7.1 Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.

19.8 Current Transmitters.

19.8.1 AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.

19.8.2 Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.

19.8.3 Unit shall be split-core type for clamp-on installation on existing wiring.

19.9 Current Transformers.

19.9.1 AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.

19.9.2 Transformers shall be available in various current ratios and shall be selected for $\pm 1\%$ accuracy at 5 A full-scale output.

19.9.3 Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

19.10 Voltage Transmitters.

19.10.1 AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.

19.10.2 Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.

19.10.3 Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

19.11 Voltage Transformers.

19.11.1 AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.

19.11.2 Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide $\pm 0.5\%$ accuracy at 24 Vac and 5 VA load.

19.11.3 Windings (except for terminals) shall be completely enclosed with metal or plastic.

19.12 Power Monitors.

19.12.1 Power monitors shall be three-phase type and shall have three-phase disconnect and shorting switch assembly, UL listed voltage transformers, and UL listed split-core current transformers.

19.12.2 Power monitors shall provide selectable output: rate pulse for kWh reading or 4-20 mA for kW reading. Power monitors shall operate with 5 A current inputs and maximum error of $\pm 2\%$ at 1.0 power factor or $\pm 2.5\%$ at 0.5 power factor.

19.13 Current Switches.

19.13.1 Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

19.14 Pressure Transducers.

- 19.14.1 Transducers shall have linear output signal and field-adjustable zero and span.
- 19.14.2 Continuous operating conditions of positive or negative pressure 50% greater than calibrated span shall not damage transducer sensing elements.
- 19.14.3 Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Transducer shall have 4-20 mA output, suitable mounting provisions, and block and bleed valves.
- 19.14.4 Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Over-range limit (differential pressure) and maximum static pressure shall be 2000 kPa (300 psi.) Transducer shall have 4-20 mA output, suitable mounting provisions, and 5-valve manifold.
- 19.15 Differential Pressure Switches. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

20.0 NETWORKS

- 20.1 BAS contractor to coordinate with the City's IT department for the connections to the City's Network.
- 20.2 Design for the Network LAN (BC LAN) shall include the following provisions:
 - 20.2.1 Provide access to the BC LAN from a remote location, via the Intranet.
 - 20.2.2 The network LAN shall utilize BACnet/IP (ASHRAE standard SPC-135A-2004 - Annex L) for communication between BCs. Manufacturer specific proprietary protocols, gateways, or protocol converters are not acceptable for this project. The OWS shall communicate to the BCs utilizing standard Ethernet to IEEE 802.3 Standards.
 - 20.2.3 High-speed data transfer rates for alarm reporting, quick report generation from multiple controllers and upload/download efficiency between network devices.
 - 20.2.4 Detection and accommodation of single or multiple failures of workstations, controller panels and the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.
 - 20.2.5 Message and alarm buffering to prevent information from being lost.
 - 20.2.6 Error detection, correction, and retransmission to guarantee data integrity.
 - 20.2.7 Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.
 - 20.2.8 Commonly available, multiple sourced, networking components shall be used to allow the system to coexist with other networking applications such as office automation. ETHERNET is the only acceptable technology.
 - 20.2.9 Synchronization of the real-time clocks in all BC panels shall be provided.
 - 20.2.10 The BC LAN shall be a 100 Megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Building Controllers (BCs), user workstations and where specified, a local server. Local area network minimum physical and media access requirements:
 - 20.2.10.1 Ethernet; IEEE standard 802.3

- 20.2.10.2 Cable; 100 Base-T, UTP-8 wire, category5
- 20.2.10.3 Minimum throughput; 10 Mbps, with ability to increase to 100 Mbps

20.2.11 Provide access to the BC LAN via a Wireless Application Protocol (WAP) device as well. Through this connection the BC LAN will provide authorized staff with the ability to monitor and control the BAS from any location within the City network through a web browser, cellular phone, pager, WebPads, or PDA. (Pocket Computer).

21.0 SERVER FUNCTION

21.1 Local connections shall be via an Ethernet LAN.

21.2 It shall be possible to provide access to all Building Control Units (BC) via a single connection to the server. In this configuration, each Building Control Unit (BC) can be accessed from an Operator Workstation (OWS) using a standard Web browser by connecting to the BAS LAN. The server shall provide the following functions, as a minimum:

- 21.2.1 Global Data Access: The server shall provide complete access to distributed data defined anywhere in the system.
- 21.2.2 Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any Building Control Unit (BC) in the network, local or remote.
- 21.2.3 The server shall include a master clock service for its subsystems and provide time synchronization for all Building Control Units (BC).
- 21.2.4 The server shall accept time synchronization messages from trusted precision Atomic Clock Internet sites and update its master clock based on this data.
- 21.2.5 The server shall provide scheduling for all Building Control Units and their underlying field control devices.
- 21.2.6 The server shall provide demand limiting that operates across all Building Control Units. The server must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shedding lists for effective demand control.
- 21.2.7 The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Building Control Units. Systems not employing this prioritization shall not be accepted.
- 21.2.8 Each Building Control Unit supported by the server shall have the ability to archive its log data, alarm data and database to the server, automatically. Archiving options shall be user-defined including archive time and archive frequency.
- 21.2.9 The server shall provide central alarm management for all Building Control Units supported by the server. Alarm management shall include:
 - 21.2.10 Routing of alarms to display, printer, email and pagers
 - 21.2.11 View and acknowledge alarms
 - 21.2.12 Query alarm logs based on user-defined parameters
- 21.2.13 The server shall provide central management of log data for all Network Control Units supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:
 - 21.2.14 Viewing and printing log data
 - 21.2.15 Exporting log data to other software applications
 - 21.2.16 Query log data based on user-defined parameters
- 21.2.17 Minimum BACnet features supported are
 - Standard BACnet Objects (Analog In/Out/Value, BinaryInput/Output/Value, Multi-State -- Input/Output/Value, Schedule(export), Calendar(export), Trend(Export), Device).
 - Segmented Capability (Segmented Request-Segmented Response).
 - Application Services (Read Property, Read Property Multiple, Write Property, Write Property Multiple, Confirmed Event, Notification, Acknowledge Alarm, Get Alarm Summary Who-has, I-have, Who-is, I-am, Subscribe COV, Confirmed COV notification, Unconfirmed COV notification).

-BACnet Broadcast Management

22.0 SCOPE OF WORK

- 22.1 The work covered by this specification and related sections consists of providing shop drawings, equipment, labour, materials, engineering, technical supervision, and transportation as required to furnish and install a fully operational BAS to monitor and control the facilities listed herein, and as required to provide the operation specified in strict accordance with these documents, and subject to the terms and conditions of the contract. The work in general consists of but is not limited to, the following:
- 22.1.1 The preparation of submittals and provision of all related services.
- 22.1.2 Operator workstations located as listed in the specifications (OWS will be provided by the City's IT, SEE PART 2, SECTION 1.1.4).**
- 22.1.3 Furnish and install all controllers to achieve system operation, any control devices, conduit and wiring, in the facility as required to provide the operation specified.
- 22.1.4 Furnish and load all software required to implement a complete and operational BAS.
- 22.1.5 Furnish complete operating and maintenance manuals and field training of operators, programmers, and maintenance personnel.
- 22.1.6 Perform acceptance tests, commissioning or re-commissioning as indicated.
- 22.1.7 Provide full documentation for all application software and equipment.
- 22.1.8 Miscellaneous work as indicated in these specifications.

23.0 PERMITS, FEES AND CODES

- 23.1 Apply for, obtain and pay for all permits, licenses, inspections, examinations and fees required. Also submit, if required, information and other data that may be obtained from the Engineer. Should the authorities require the information on specific forms, fill in these forms by transcribing the information provided by the Engineer.
- 23.2 BAS contractor shall obtain and pay for the police clearance certificates if required for the project.
- 23.3 Arrange for inspection of all work by the authorities having jurisdiction over the Work. On completion of the Work, present to the Engineer the final unconditional certificate of approval of the inspecting authorities.
- 23.4 Comply with the requirements of the latest edition of the applicable ULC or CSA standards, the requirements of the Authorities, Federal, Provincial/Territorial and Municipal Codes, the applicable standards of ULC and all other authorities having jurisdiction. These Codes and Regulations constitute an integral part of these Specifications.
- 23.5 Where there is no alternative to supply equipment which is CSA certified, submit such equipment to the local electrical authority for special inspection and obtain approval before delivery of equipment to site.
- 23.6 In case of conflict, applicable Codes take precedence over the Contract Documents. In no instance reduce the standard or Scope of Work or intent established by the Drawings and Specifications by applying any of the Codes referred to herein.
- 23.7 Before starting any work, submit the required number of copies of documentation to the authorities for their approval and comments. Comply with any changes requested as part of the Contract, but notify the

Engineer immediately of such changes, for proper processing of these requirements. Prepare and furnish any additional drawings, details or information as may be required.

24.0 COORDINATION

- 24.1 All work shall be performed at times acceptable to the Engineer/Construction Manager. Provide work schedule at the start of the job for the approval of the Engineer/Construction Manager. Schedule shall show when all staff and sub-contractors shall be on-site.
- 24.2 Organize all sub-contractors and ensure that they maintain the schedule.
- 24.3 Full cooperation shall be shown with other sub-contractors to facilitate installations and to avoid delays in carrying out the work.
- 24.4 Notify Engineer/Construction Manager of any changes to the schedule. Send any schedule changes and weekly progress reports via fax to Engineer/Construction Manager.
- 24.5 Where, in the judgment of the Engineer/Construction Manager, the work could disrupt the normal operations in or around the building, contractor shall schedule work to eliminate or minimize interference, subject to owner's approval.
- 24.6 When connecting to the existing systems, advise the Engineer/Construction Manager and obtain permission to so. Perform work at a time acceptable to the Engineer/Construction Manager and Owner.

24.0 SUPERVISION OF PERSONNEL

- 24.1 Maintain at this building qualified personnel and supporting staff with proven experience in erecting, supervising, testing, and adjusting projects of comparable nature and complexity.
- 24.2 Supervisory personnel and their qualifications are subject to the approval of the Owner.
- 24.3 All personnel working on-site shall sign in as required by the Owner and shall wear company identification.
- 24.4 When requested and for whatever reason, remove personnel and/or support staff from project. Take immediate action. Contractors and subcontractors may require police clearance.

25.0 ELECTRICAL WORK AND SAFETY REQUIREMENTS

- 25.1 Control and interlock wiring and installation shall comply with national and local electrical codes, and manufacturer's recommendations.
- 25.2 CEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by CEC.
- 25.3 Low-voltage wiring shall meet CEC Class 2 requirements. Subfuse low-voltage power circuits as required to meet Class 2 current limit.
- 25.4 CEC Class 2 (current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.
- 25.5 Install wiring in raceway where subject to mechanical damage and at levels below 3 m (10ft) in mechanical, electrical, or service rooms.
- 25.6 Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

- 25.7 Install Class 1 and Class 2 wiring in separate raceways. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two through relays and transformers.
- 25.8 Do not install wiring in raceway containing tubing.
- 25.9 Run exposed Class 2 wiring parallel to a surface or perpendicular to it and tie neatly at 3 m (10 ft) intervals.
- 25.10 Use structural members to support or anchor plenum cables without raceway. Do not use ductwork, electrical raceways, piping, or ceiling suspension systems to support or anchor cables.
- 25.11 Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes shall not be hung on or attached to ductwork, electrical raceways, piping, or ceiling suspension systems.
- 25.12 Size raceway and select wire size and type in accordance with manufacturer's recommendations and CEC requirements.
- 25.13 Include one pull string in each raceway 2.5 cm (1 in.) or larger.
- 25.14 Use color-coded conductors throughout.
- 25.15 Locate control and status relays in designated enclosures only. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.
- 25.16 Conceal raceways except within mechanical, electrical, or service rooms. Maintain minimum clearance of 15 cm (6 in.) between raceway and high-temperature equipment such as steam pipes or flues.
- 25.17 Install insulated bushings on raceway ends and enclosure openings. Seal top ends of vertical raceways.
- 25.18 Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.
- 25.19 Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Do not use flexible metal raceway less than ½ in. electrical trade size. Use liquid-tight flexible metal raceways in areas exposed to moisture including chiller and boiler rooms.
- 25.20 Install raceway rigidly, support adequately, ream at both ends, and leave clean and free of obstructions. Join raceway sections with couplings and according to code. Make terminations in boxes with fittings. Make terminations not in boxes with bushings.
- 25.21 All equipment and systems installed under this Contract shall be grounded, isolated, or conditioned as required to permit equipment to continue to function normally, without interruption, in the event of radio frequency interference (RFI), electromagnetic interference (EMI), power surges/dips or other electrical anomalies.
- 25.22 It shall be the responsibility of the Contractor or his Sub-contractor to ensure that any coring of holes through the walls or floors will not penetrate existing conduits, cables or mechanical equipment in or under the floor slabs or walls. He shall be responsible to take any and all action as deemed necessary by the Project Manager to correct any such penetrations at his cost. No coring shall be undertaken unless the Project Manager gives permission. Scan walls and floors prior to core drilling to identify hidden piping. Ensure that water does not flow into equipment and below floors. Waterproof and fire stop all penetrations.

26.0 COMMUNICATION WIRING

- 26.1 Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article 25 (Electrical Work).
- 26.2 Install communication wiring in separate raceways and enclosures from other Class 2 wiring.

- 26.3 During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.
- 26.4 Verify entire network's integrity following cable installation using appropriate tests for each cable.
- 26.5 Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.
- 26.6 Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.
- 26.7 Label communication wiring to indicate origination and destination.
- 26.8 Ground coaxial cable according to OEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

27.0 LOCKABLE PANELS

- 27.1 Indoor control panels shall be fully enclosed NEMA 1 construction with hinged door key-lock latch and removable sub-panels. A common key shall open each control panel and sub-panel.
- 27.2 Prewire internal and face-mounted device connections with color-coded stranded conductors tie-wrapped or neatly installed in plastic troughs. Field connection terminals shall be UL listed for 600 V service, individually identified per control and interlock drawings, with adequate clearance for field wiring.
- 27.3 Each local panel shall have a control power source power switch (on-off) with overcurrent protection.

28.0 WARNING LABELS

- 28.1 All Controller panels Affix permanent warning labels to equipment that can be automatically started by the control system.
1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows.

CAUTION

This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

- B. Affix permanent warning labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.

1. Labels shall use white lettering (12-point type or larger) on a red background.
2. Warning labels shall read as follows.

CAUTION

This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

29.0 IDENTIFICATION OF HARDWARE AND WIRING

- 29.1 Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 5 cm (2 in.) of termination.
- 29.2 Permanently label or code each point of field terminal strips to show instrument or item served.
- 29.3 Label control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.
- 29.4 Label each control component with a permanent label. Label plug-in components such that label remains stationary during component replacement (lamacoids).
- 29.5 Label room sensors related to terminal boxes or valves with nameplates (lamacoids).
- 29.6 Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- 29.7 Label identifiers shall match record documents.
- 29.8 Insert laminated points list in the control panel

30.0 PRELIMINARY DESIGN REVIEW

- 30.1 The BAS contractor shall submit a preliminary design document for review. This document shall contain the following information:
 - 30.1.1 Provide a description of the proposed system along with a system architecture diagram with the intention of showing the contractors solution to meet this specification.
 - 30.1.2 Provide product data sheets and a technical description of BC, AAC, ASC hardware required to meet specifications listed herein.
 - 30.1.3 Provide product brochures and a technical description of the Server, Operator Workstation, and Building Control Unit (BC) software required to meet this specification. Provide a description of software programs included.
 - 30.1.4 Open Protocols - For all hardware Building Controllers, Advanced Application Controllers (AAC) and Advanced Specific Controllers (ASC), provide BACnet Interoperability Building Blocks BIBBs certification. Provide complete description and documentation of any proprietary services and/or objects where used in the system.
 - 30.1.5 Provide a description and samples of Operator Workstation graphics and reports.
 - 30.1.6 Provide an overview of the BAS contractor's local/branch organization, local staff, recent related project experience with references, and local service capabilities.
 - 30.1.7 Provide information on the BAS contractors project team including project organization, project manager, project engineer, programmers, project team resumes, and location of staff.

31.0 DRAWING REQUIREMENTS

- 31.1.1 Within 45 days of award of contract and before start of construction, submit 3 hard copies and 1 soft copy of manufacturers information and shop drawings. Soft copy to be in AutoCAD or VISIO and WordPerfect or Word formats (latest versions) structured using menu format for easy loading and retrieval on the OWS.
- 31.1.2 Manufacturer's Data: Provide in completely coordinated and indexed package to assure full compliance with the contract requirements. Piecemeal submittal of data is not acceptable and such submittals will be returned without review. Information shall be submitted for all material and equipment the contractor proposes to furnish under terms of this contract work. Arrange the

submittals in the same sequence as these specifications and reference at the upper right-hand corner the particular specification provision for which each submittal is intended. Submittals for each manufactured item shall be manufacturer's descriptive literature (equipment specification), equipment drawings, diagrams, performance and characteristic curves, and catalog cuts, and shall include the manufacturer's name, trade name, catalog model or number, nameplate data, size layout dimension, capacity, specification reference, applicable specification references, and all other information necessary to establish contract compliance.

31.1.3 Shop drawings: Provide in completely coordinated and indexed package:

31.1.3.1Wiring and piping diagrams.

31.1.3.2Control schematics with narrative description and control descriptive logic fully showing and describing operation and/or manual procedures available to operating personnel to achieve proper operation of the building, including under complete failure of the BAS.

31.1.3.3Shop drawings for each input/output point showing all information associated with each particular point including sensing element type and location; details of associated field wiring schematics and schedules; point address; software and programming details (CDL's) associated with each point; and manufacturer's recommended installation instructions and procedures for each type of sensor and/or transmitter.

31.1.3.4Detailed system architecture showing all points associated with each controller, controller locations, and describing the **spare points capacity** at each controller and BAS LAN.

31.1.3.5Each BC shall contain a minimum of 20% spare resource capacity. The BC shall provide a throughput capable of transmitting all BAS LAN data connected to it within 10 seconds.

31.1.3.6Each AAC and ASC shall have a minimum of 10% spare capacity for each point type for future point connection. Provide all processors, power supplies and communication controllers complete so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring. As a minimum, provide one of each type of point available on the controller.

31.1.3.7Specification sheets for each item including manufacturers descriptive literature, drawings, diagrams, performance and characteristic curves, manufacturer and model number, size, layout, dimensions, capacity, etc

31.1.3.8Colour graphic displays detailing hierarchical structure of facility, including floor plans, with multi-level penetration to equipment level.

32.0 START-UP AND CHECKOUT

City's BAS Project Manager shall be present during the Start-Up and Checkout- FOR FACILITIES MANAGEMENT PROJECTS ONLY, FOR OTHER DIVISIONS THIS IS OPTIONAL

32.1 This work shall include field testing and adjustment of the complete BAS, and on-site final operational acceptance test of the complete operational BAS. The Engineer shall be advised at least 14 days in advance of the dates of all tests and may attend at his discretion. If the Engineer witnesses the test, such tests shall be subject to his approval prior to the release of equipment. If the Engineer elects not to witness the tests, the contractor shall provide performance certification. Acceptance of tests by the Engineer and Project Manager shall not relieve the contractor of responsibility for the complete system meeting the requirements of these specifications after installation.

32.2 Static testing:

32.2.1 Static testing shall include point-by-point testing of the entire system and completion of Component Test Sheets. The contractor shall forward proposed Test Sheets at the shop drawing review stage. These Component Test Sheets shall be completed during the contractor's own testing and verification procedure that is done prior to the request for a final inspection. The completed Component Test Sheets shall then be returned to the Engineer for review and approval. The Engineer may repeat a random sampling of at least 50% of the tests during the Engineers commissioning procedure to corroborate their accuracy. The Contractor shall be on site with test equipment during this verification process. The test procedures shall include the following.

32.2.1.1 Digital input component testsheet:

32.2.1.1.1 DI status shall be verified at the POT and OWS for ON and OFF status.

32.2.1.1.2 All digital alarm inputs shall be proven using actual field conditions where possible or be jumpered at the field device for testing with the approval of the Engineer.

32.2.1.2 Digital output component testsheet:

32.2.1.2.1 Status to be verified at the equipment location. Verification at the OWS shall be completed for ON and OFF status, software DISABLE indicator and OVERRIDEN indicator

32.2.1.3 Analog input component testsheet:

32.2.1.3.1 All temperature sensors shall be calibrated using a hand held meter with equal or better accuracy.

32.2.1.3.2 Selected temperature sensors chosen by the Engineer shall be verified by spraying with a cold spray or other means to ensure response and to test the low temperature alarm condition.

32.2.1.3.3 All pressure sensing devices and analog output feedback shall be verified using a device with equal or better accuracy to ensure correct calibration.

32.2.1.3.4 All humidity sensing devices must be verified using a recently calibrated device with equal or better accuracy

32.2.1.3.5 All CTs shall be set to accurately reflect motor status, including removing belts on belt driven equipment

32.2.1.3.6 All other devices shall be verified using appropriate devices of equal or better accuracy

32.2.1.3.7 Adjust span on feedback devices so that input matches the end device

32.2.2 Analog output component testsheet:

32.2.2.1 AI points shall be tested by sending a command from the PWS or OWS to incrementally stroke the field device from full CLOSED to full OPEN and measuring the signal at the field device. The increments of the test shall be no larger than 10% of the output span.

32.2.2.2 The AO feedback requirement shall also be tested by failing the field device and verifying that the alarm registers

32.2.2.3 Each output shall be exercised over the full output capability of the panel

32.2.2.4 Field device hysteresis shall be measured at a minimum of three output levels for each direction of travel. Output increments shall not exceed 2% of span for this test

33.0 STANDARDS COMPLIANCE

33.1 Where materials or equipment are specified to conform to requirements of the standards of organizations, such as the Canadian Standards Association (CSA) that use a label or listing as method of indicating compliance, proof of such conformance shall be submitted and approved, indexed and cross-referenced with the specification. The label or listing of the specified organization will be acceptable evidence. In lieu of the label or listing, the contractor shall submit a certificate from a testing organization adequately equipped and competent to perform such services, and approved by the Engineer, stating that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard or code. For materials whose compliance with organizational standards or specifications is not regulated by an organization using its own listing or label as proof of compliance, a certificate from the manufacturer shall be furnished to the Engineer stating that the material complies with the applicable referenced standard or specification.

34.0 FINAL ACCEPTANCE

34.1 Final acceptance shall commence only after satisfactory completion of start-up, verification of performance and the 30-day test period described earlier. When the Contractor has satisfied himself as to proper system operation he shall advise the BAS Commissioning Engineer/Consultant to establish a date for Final Acceptance. This will involve a point-by-point check of all hardware and software items including graphics and displayed data, as well as performing tasks as directed.

34.2 Supply 2-way radios and all test equipment as previously specified. Have on-site technical personnel capable of re-calibrating all field hardware and modifying software.

34.3 Test each system independently and then in unison with other related systems. Test weather sensitive systems twice- once near winter design conditions and again near summer design conditions.

34.4 Optimize operation and performance of each system. Test full-scale emergency operation and integrity of smoke management and other life safety systems.

34.5 Demonstrate to the Engineer the operation of each system including sequence of operations in regular and emergency modes, under all normal and emergency conditions, start-up, shut-down, interlocks, and lock-outs.

34.6 Upon completion of the testing submit a report to the Engineer to summarize all testing.

35.0 DOCUMENTATION

35.1 Documentation shall consist of 4 hard copies and one soft copy for all information described below

35.2 The final documentation package shall include:

35.2.1 Hard and soft copies of all control drawings (As-Builts).

35.2.2 Manufacturer's technical data sheets for all hardware and software

35.2.3 Factory operating and maintenance manuals with any customization required

35.2.4 Soft copies of programming and front-end software and each controller's database. Hard copy output of programming is not necessary

- 35.2.5 Provide clear, concise, typewritten and soft copy descriptions of all control sequences in the working language.
- 35.2.6 Soft copy text files shall be in MS-Word.
- 35.3 Each instruction and reference manual shall be bound in hardback, 3 ring, binders or an approved equivalent shall be provided to the Engineer. Binders to be no more than 2/3 full. Each binder to contain index to full volume. One complete set of manuals shall be furnished prior to the time that the system or equipment tests are performed, and the remaining manuals shall be furnished at acceptance. The identification of each manual's contents shall be inscribed on the cover and spine. The manuals shall include the names, addresses and telephone numbers of each subcontractor installing equipment systems and of the local representatives for each item of equipment and each system. The manuals shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. Additionally, each manual shall contain a comprehensive index of all manuals submitted in accordance with this paragraph. Manuals and specifications shall be furnished which provide full and complete coverage of the following subjects:
- 35.4 Operational Requirements: This document shall describe in concise terms, all the functional and operational requirements for the system and its functions that have been implemented. It shall be written using common terminology for building operation staff and shall not presume knowledge of digital computers, electronics or in-depth control theory.
- 35.5 System Operation: Complete step by step procedures for operation of the system, including required actions at each operator station; operation of computer peripherals; input and output formats; and emergency, alarm and failure recovery. Step-by-step instructions for system startup, back-up equipment operation, and execution of all system functions and operating modes shall be provided.
- 35.6 Maintenance: Documentation of all maintenance procedures for all system components including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective module. This shall include calibration, maintenance, and repair or replacement of all system hardware.
- 35.7 Test Procedures and Reports: The test implementation shall be recorded with a description of the test exercise script of events and documented as test procedures. A provision for the measurement or observation of results, based on the previously published test specification, forms the test reports. The procedures record and the results of these exercises shall be conveniently bound and documented together.
- 35.8 Configuration Control: Documentation of the basic system design and configuration with provisions and procedures for planning, implementing, and recording any hardware or software modifications required during the installation, test, and operating lifetime of the system. This shall include all information required to ensure necessary coordination of hardware and software changes, data link or message format/content changes, and sensor or control changes in the event system modification are required, and to fully document such new system configurations.

36.0 TRAINING

- 36.1 The Contractor shall provide the services of competent instructors who will provide instruction to designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified. The training shall be oriented towards the system installed rather than being a general "canned" training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The number of person-days (eight hours) of instruction furnished shall be as specified below as a minimum. A training manual shall be provided for each trainee that describes in detail the data included in each training program.
- 36.2 All equipment and material required for classroom training shall be provided by the contractor. A person-week shall be considered as 37.5 hours, 8:00 am to 12:00 noon, and 12:30 pm to 4:30 pm Monday through Friday. Provide 5 days of training as specified herein.

36.3 Training shall enable operators to accomplish the following objectives:

- 36.3.1 Proficiently operate system
- 36.3.2 Understand control system design and configuration
- 36.3.3 Create and change system graphics
- 36.3.4 Create, delete, and modify alarms, including configuring alarm reactions
- 36.3.5 Configure and run reports
- 36.3.6 Add, remove, and modify system's physical points
- 36.3.7 Create, modify, and delete application programming
- 36.3.8 Add a new controller to system
- 36.3.9 Download firmware and advanced applications programming to a controller
- 36.3.10 Configure and calibrate I/O points
- 36.3.11 Maintain software and prepare backups
- 36.3.12 Understand DDC system components
- 36.3.13 Understand system operation, including DDC system control and optimizing routines (algorithms)
- 36.3.14 Operate workstation and peripherals
- 36.3.15 Log on and off system
- 36.3.16 Access graphics, point reports, and logs
- 36.3.17 Adjust and change system setpoints, time schedules, and holiday schedules
- 36.3.18 Recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools
- 36.3.19 Access data from DDC controllers
- 36.3.20 Add new users and understand password security procedures

37.0 WARRANTY

- 37.1 Provide warranty certificates showing the name of the firm giving the warranty, dated from the issuance of the Certificate of Substantial Performance and acknowledged on specific equipment and systems.
- 37.2 Include these certificates with the Operation and Maintenance Manual in the appropriate sections.
- 37.3 Contractor shall give a minimum two-year warranty for parts and labor on all equipment and materials installed and shall select materials and equipment where the Manufacturer gives the same warranty arrangements. Warranty shall commence on the date of the Engineers issuance of the Certificate of Substantial Completion.
- 37.4 Provide a warranty as indicated in 38.0 - Maintenance/Service.

- 37.5 The Contractor shall agree to make good at his own expense any equipment that fails to operate due to poor workmanship, manufacturing defect or improper installation. Any repairs shall be made at the convenience of the Engineer during normal working hours, unless deemed an emergency.
- 37.6 Provide upgrades to all software or all panel firmware issued during the warranty period at no charge to Owner.

38.0 MAINTENANCE/SERVICE

*BAS contractor to show the price of service contract as separate line item.
Applicable to New System Installations OR Major overhaul of existing BAS system/s*

- 38.1 Provide warranty in accordance with the warranty section of this specification. In addition provide scheduled maintenance and service during the warranty period on all control system apparatus including but not limited to valves, dampers, linkages, control panels, interfaces, direct digital control systems, OWS, Server, BC, AAC, ASC, Software and application programs.
- 38.2 Scheduled preventive maintenance inspections will provide those services required to maintain the system at maximum performance and reliability levels and may include the following:
- 38.3 Analyze, adjust, calibrate the applicable temperature sensors, humidity sensors, diagnostic LEDs, printers, power supplies, work stations, controllers, modems, input/output points, communication cabling, transmitters, transducers, UPS for the BAS system.
- 38.4 Conduct inspections and thorough preventive maintenance routine on each piece of covered equipment. In addition, make tests and adjustments to ensure efficient and reliable operation of other major components.
- 38.5 Examine, clean and calibrate as required sensors, thermostats, humidity controls, temperature controls, pressure controls, relays, damper actuators, instrumentation and accessories directly pertaining to the Building Automation System.
- 38.6 Check and confirm control system sequence of operation to insure optimum system efficiency and economy.
- 38.7 A log of each loop tested and each control sequence verified shall be reviewed with the owner.
- 38.8 All components of the Pneumatics Control System will be serviced according to manufacturer's recommendations during each year of the contract. This will include (but not be limited to) all lubricant changes, filter changes, adjustments, calibrations and cleaning.
- 38.9 The system includes, but is not limited to, the air compressor, air receiver, pressure reducing valves, air dryers and all sensors, controllers, transducers, damper and valve operators, thermostats, pilot positioners, electro-pneumatic switches, linkages and any other pneumatic and electronic devices used to maintain the environmental comfort in the building.
- 38.10 The Contractor will provide preventative maintenance and diagnostic inspections to all electronic system components on a frequency established by manufacturer's recommendations, component age and condition and discussion with the Supervisor of Operations responsible for the site.
- 38.11 Provide a fully trained BAS service technician and a Pneumatic fitter (Required for Pneumatic/DDC system) a minimum of one day per month (8 hours for DDC technician and 8 hours for pneumatic fitter) during the warranty period to provide the preventive maintenance and service described above. Provide

written reports to the owner outlining the work performed. Allow for 12 annual visits of one day each (24 days total for 2 years) during the warranty period to provide required service. (This may change in accordance with the size of the project).

- 38.12 Provide emergency service for parts and labor on an as needed basis. Response to an emergency call shall be 2 hours maximum on Mon.-Fri. including on holidays and weekends.
- 38.13 Provide remote service diagnostic monitoring from the local office. At the request of the owner, a service diagnostic call will be made to troubleshoot and resolve (if possible) any reported system complaints.
- 38.14 Provide a price for a three-year service agreement based on the above requirements to come in to effect upon the completion of the warranty period. Show this price as OPTION: Service Agreement.

PART 2 – OPERATOR WORKSTATION (OWS) AND SOFTWARE

1.0 GENERAL

- 1.1 General Requirements: Section 23 09 23 BUILDING AUTOMATION SYSTEM (BAS)
- 1.2 Performance requirements of the Operator WorkStation (OWS) and the Graphical Users Interface are specified in this section.
- 1.3 Environmental Conditions: The OWS and its immediate associated devices shall be able to operate properly under environmental conditions of 10 deg.C to 32 deg.C and a relative humidity of 20 to 90% non-condensing.
- 1.4 **OWS shall be provided by the City's IT department.** BAS contractor shall **NOT** include the cost of the computer for the pricing of the project. The OWS shall be provided for centralized system control, information management, alarm management and data base management functions. All real time control functions shall be resident in the standalone Building Control Unit (BC) and local controllers (AACs and ASCs).
- 1.5 Provide two copies of all Programming Software; one each for OWS and a laptop; **if requirement of a laptop is deemed necessary otherwise provide only one copy. Requirement of a laptop is site specific and shall be provided by the City's IT department. City's project manager shall consult with the district operation manager/supervisor to determine if a laptop is required for the project.**
- 1.6 Any computer on the BAS LAN shall be capable of displaying the systems in a graphical and dynamic format utilizing a standard web browser. Screen refresh shall be automatic. Manual refresh is not acceptable.

2.0 WORKSTATION HARDWARE REQUIREMENTS

- 2.1 Reference 1.1.5
- 2.2 BAS contractor shall coordinate with the City's IT department through the project manager to discuss minimum requirement of the workstation's (computer) hardware, software (operating system) to ensure BAS system will meet or exceed the performance requirement of this specifications.
- 2.3 Connection to the BAS LAN network shall be via an Ethernet network interface card, 100 Mbps.
- 2.4 Provide ____ Workstations. The Workstation(s) will be located as directed by the engineer.
- 2.5 **This Item is for guidance only.** Hardware Base. Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications. Hard disk shall have sufficient memory to store system software, one year of data for trended points specified by the consultant's sequence of operation and the points list. Workstations shall be with a minimum of:

- 2.5.1 Intel Pentium 2.66 GHz processor (Pentium IV- Duo Core)
- 2.5.2 8 GB RAM
- 2.5.3 100 GB hard disk providing data at 100 MB/sec
- 2.5.4 48x CD-ROM drive
- 2.5.5 Keyboard
- 2.5.6 Mouse
- 2.5.7 24-inch 24-bit color monitor with at least 1024 x 768 resolution
- 2.5.8 Serial, parallel, and network communication ports and cables as required for proper system operation
- 2.5.9 Two (2) USB 2.0 or 3.0 ports

3.0 PRINTERS

- 3.1 BAS contractor to coordinate with the City's IT department through the project manager to ensure a network printer is connected to the Operator Workstation that is provided by the City's IT department.
- 3.2 If the site doesn't have a printer available then City's IT department shall provide a desktop printer.
- 3.3 **Printer Specifications- For Guidance only:** The printer shall be a bubble jet or inkjet printer, 1440 x1440 dpi resolution, internal 1MB buffer memory, minimum 8 ppm in black. No colour printer is required.

4.0 UNINTERRUPTABLE POWER SUPPLIES

- 4.1 Provide the OWS, Server (if applicable), and each BC with individual UPS to provide clean, reliable, noise-filtered power at all times and to protect and maintain systems operation throughout short term power interruptions of at least 15 minutes duration. (site specific)

5.0 PROGRAMMING SOFTWARE

- 5.1 Custom Application Programming. Operator shall be able to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
 - 5.1.1 Language. Language shall be graphically based or English language oriented. If graphically based, language shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks. If English language oriented, language shall be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and shall allow for free-form programming that is not column-oriented or "fill-in-the-blanks."
 - 5.1.2 Programming Environment. Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.
 - 5.1.3 Independent Program Modules. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.
 - 5.1.4 Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate

actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.

- 5.1.5 Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
- 5.1.6 Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.
- 5.1.7 Variables: Operator shall be able to use variable values in program conditional statements and mathematical functions.
 - 5.1.7.1 Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.
 - 5.1.7.2 System Variables. Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.
- 5.2 The software shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the software shall be through password access as assigned by the system administrator.
- 5.3 Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.
- 5.4 Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's flywheel effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.

FOR TRIDIUM INTEGRATION (IF APPLICABLE) BAS CONTRACTOR SHALL CONFORM TO ITEMS 5.1, 5.2, 5.3, 5.4 PLUS ITEM 5.5

- 5.5 A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide real-time data updates. Any real-time data value or object property may be connected to display its current value on a user display.

Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

5.5.1 Programming Methods

- 5.5.1.1 Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in colour depending on the type of link; i.e., internal, external, hardware, etc.
- 5.5.1.2 Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
- 5.5.1.3 The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
- 5.5.1.4 All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
- 5.5.1.5 The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.
- 5.5.1.6 The user shall be able to pick a graphical function block from the menu and place on the screen. Programming tools shall place lines connecting appropriate function blocks together automatically. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.
- 5.5.1.7 The programming tools shall include a test mode. Test mode shall show user real-time data on top of graphical display of selected function blocks. Data shall be updated real-time with no interaction by the user. Function blocks shall be animated to show status of data inputs and outputs. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.
- 5.5.1.8 Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the contained application that are represented on the graphical shell of this container.

5.6 OPERATOR WORKSTATION SOFTWARE

5.6.1 Operating System: City's IT department will provide OWS including operating system.

- 5.6.2 The BAS software shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to,

forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

5.6.3 Real-Time Displays. The OWS, shall at a minimum, support the following graphical features and functions:

5.6.3.1 Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.

5.6.3.2 Graphic screens shall have the capability to contain objects for text, real-time values, animation, colour spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URLs, and links to other graphic screens.

5.6.3.3 Graphics shall support layering and each graphic object shall be configurable for assignment to one a layer. A minimum of six layers shall be supported.

5.6.4 Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

5.6.5 Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.

5.6.6 Right-clicking the selected object and using a graphical slider to adjust the value shall make adjustments to analog objects, such as set points. No entry of text shall be required.

5.6.7 System Configuration. At a minimum, the OWS shall permit the operator to perform the following tasks, with proper password access:

5.6.7.1 Create, delete or modify control strategies.

5.6.7.2 Add/delete objects to the system.

5.6.7.3 Tune control loops through the adjustment of control loop parameters.

5.6.7.4 Enable or disable control strategies.

5.6.7.5 Generate hard copy records or control strategies on a printer.

5.6.7.6 Select points to be alarm-able and define the alarm state.

5.6.7.7 Select points to be trended over a period of time and initiate the recording of values automatically.

5.6.8 On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.

5.6.9 Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This

auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

- 5.6.10 System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
- 5.6.11 Alarm Console. The system shall be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and unacknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.
- 5.6.12 Operator's workstation software shall contain an easy-to-operate system; allowing configuration of system-wide controllers, including management and display of the controller programming. This system shall provide the capability to configure controller binary and analog inputs/outputs.
- 5.6.13 The system shall be capable of utilizing third-party Windows-based programs for such things as spreadsheet analysis, graphing, charting, custom report generation, and graphics design packages. Graphics generation shall be done using standard Windows packages. No proprietary graphics generation software shall be needed.
- 5.6.14 Provide software, which enables the non-programmer operator to easily perform, tasks which are likely to be part of his daily routine.
- 5.6.15 The operator's console shall provide facilities for manual entries and visual displays enabling an operator to enter information into the system and obtain displays and logs of system information. All requests for status, analog, graphic displays, logs, and control shall be selected from the operator's console. The operator interface shall minimize the use of typewriter style keyboard by implementing a mouse or similar pointing device and "point and click" approach to command selection. The facility shall be provided to permit the operator to perform the following tasks:
 - 5.6.15.1 Automatic logging of digital alarms and change of status message.
 - 5.6.15.2 Automatic logging of all analog alarms.
 - 5.6.15.3 System changes (alarm limits, set-points, alarm lock-outs, etc.).
 - 5.6.15.4 Display specific points as requested by the operator.
 - 5.6.15.5 Provide reports as requested by the operator and on Scheduled basis where so required.
 - 5.6.15.6 Display graphics as requested by the operator.
 - 5.6.15.7 Display help information.
 - 5.6.15.8 Provide trend logs as required by the operator.
 - 5.6.15.9 Provide manual control of digital and analog outputs as required by the operator.
 - 5.6.15.10 Direct the hard copy output of information to the device selected by the operator.
 - 5.6.15.11 Data displayed on monitor to cyclic update as appropriate.
- 5.6.16 Online changes:
 - 5.6.16.1 Alarm limits

5.6.16.2 Setpoints

5.6.16.3 Deadbands

5.6.16.4 Changes/deletions/additions of points.

5.6.16.5 Control and change of state changes.

5.6.16.6 Time of day, day, month, year.

5.6.16.7 Control loop control description changes for NCU based CDM's.

5.6.16.8 Control loop tuning changes

5.6.16.9 Schedule changes

5.6.16.10 Changes/additions/deletions to system graphics

5.6.16.11 Changes/additions/deletions to total systems

5.6.17 It shall be possible for the OWS operator to initiate analog and digital output commands. Where the BAS software normally originates these outputs, the provision shall exist for the operator to terminate automatic BAS control of any particular output and to originate a manual analog or digital output command. The provision shall exist for the operator to return analog or digital output command functions to automatic BAS software control.

5.6.18 It shall be possible for the OWS operator to place any computed system setpoint to a computed basis or manual value as and when required.

5.6.19 All above functions shall operate under the password protection system.

5.6.20 A vocabulary of at least 25 different descriptions using at least six alphanumeric characters to identify engineering units for analog input and output points. Typical description is as follows: %, Deg.C, KPA, KW, KWH, L/S, CFM, Deg.F, PSI. The descriptions shall be alterable from the OWS console with the system on-line.

5.6.21 Upon operator's request, the system shall present the condition of any single point, any system, and area or the whole system on printer or CRT. The output device shall be by operator's choice. Analog values and status displayed on the CRT shall be updated whenever new values are received. Points in alarm shall be flagged by blinking, inverse video different colour, bracketed, or by some other means to differentiate them from points not in alarm. Overridden (not in auto) points/values shall similarly be identified.

5.7 REPORTING ACCURACY

5.7.1 System shall report values with minimum end-to-end accuracy listed in Table 1.

5.8 CONTROL STABILITY AND ACCURACY

5.8.1 Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

Table 1
Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±0.5°C (±1°F)
Ducted Air	±0.5°C (±1°F)
Outside Air	±1.0°C (±2°F)
Dew Point	±1.5°C (±3°F)

Water Temperature	±0.5°C (±1°F)
Delta-T	±0.15°C (±0.25°F)
Relative Humidity	±5% RH for monitor only, ±3% RH for control
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa (±0.1 in. w.g.)
Air Pressure (space)	±3 Pa (±0.01 in. w.g.)
Water Pressure	±2% of full scale (see Note 2)
Electrical (A, V, W, Power Factor)	±1% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO ₂)	±50 ppm
Note 1: 10% - 100% of scale	
Note 2: For both absolute and differential pressure	
Note 3: Not including utility-supplied meters	

Table 2
Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa (±0.2 in. w.g.) ±3 Pa (±0.01 in. w.g.)	0-1.5 kPa (0-6 in. w.g.) -25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0°C (±2.0°F)	
Duct Temperature	±1.5°C (±3°F)	
Humidity	±5% RH	
Fluid Pressure	±10 kPa (±1.5 psi) ±250 Pa (±1.0 in. w.g.)	MPa (1-150 psi) 0-12.5 kPa (0-50 in. w.g.) differential

5.9 ERROR MESSAGES

- 5.9.1 Inform operator of all errors in data, errors in entry instructions, failure of equipment to respond to requests or commands, or failure of communications between components of EMCS.
- 5.9.2 Error messages to be comprehensive and communicate clearly to operator precise nature of problem.

5.10 PASSWORD PROTECTION

- 5.10.1 Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's terminal functions unless user is logged on. This includes displays as outlined above.
- 5.10.2 Each user shall have an individual User ID, User Name and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID shall be 8 characters, User Name shall be 29 characters, and Password shall be 8 characters long. Each system user shall be allowed individual assignment of only those control functions and menu items to which that user requires access. All passwords, user names, and access assignments shall be adjustable online at the operator's terminal. Each user shall also have a set security level, which defines

access to displays and individual objects the user may control. System shall include 10 separate and distinct security levels for assignment to users.

5.11 AUDIT LOGS

- 5.11.1 Provide and maintain an Audit Log that tracks all activities performed on the NCU. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NCU), to another NCU on the network, or to a server. For each log entry, provide the following data:
 - 5.11.2 Time and date
 - 5.11.3 User ID
 - 5.11.4 Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

5.12 TREND DATA

- 5.12.1 System shall periodically gather historically recorded selected samples of object data stored in the field equipment (global controllers, field controllers) and archive the information on the operator's workstation (server) hard disk. Archived files shall be appended with new sample data, allowing samples to be accumulated over several years. Systems that write over archived data shall not be allowed, unless limited file size is specified. Samples may be viewed at the operator's terminal in a trendlog. Logged data shall be stored in spreadsheet format. Operator shall be able to scroll through all trendlog data. System shall automatically open archive files as needed to display archived data when operator scrolls through the data vertically. All trendlog information shall be displayed in standard engineering units.
- 5.12.2 Software shall be included that is capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x,y) graphs that display up to six object types at the same time in different colours. Graphs shall show object type value relative to time.
- 5.12.3 Operator shall be able to change trend log setup information. This includes the information to be logged as well as the interval at which it is to be logged. All input, output, and value object types in the system may be logged. All operations shall be password protected. Setup and viewing may be accessed directly from any and all graphics on which object is displayed.
- 5.12.4 System shall be capable of periodically gathering energy log data stored in the field equipment and archive the information on the operator workstation's hard disk. Log data shall include both instantaneous and accumulated values. Archive files shall be appended with the new data, allowing data to be accumulated over several years. Systems that write over archived data shall not be allowed unless limited file size is specified. System shall automatically open archive files as needed to display archived data when operator scrolls through the data. Display all energy log information in standard engineering units.
- 5.12.5 System software shall be provided that is capable of graphing the energy log data. Software shall be capable of creating two-axis (x,y) graph that show recorded data, relative to time. All data shall be stored in comma-delimited file format for direct use by third-party spreadsheet or other database programs. Operation of system shall not be affected by this operation. In other words, it shall stay completely online.
- 5.12.6 Operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. All operations shall be password protected.

5.13 GRAPHICS

- 5.13.1 The operator's workstation shall display all data associated with the project. The operator's terminal software shall accept Windows BITMAP (*.bmp) format graphic files for display purposes. Graphic files shall be created using scanned, full colour photographs of system

- installation, AutoCAD drawing files of field installation drawings and wiring diagrams from as-built drawings. Operator's terminal shall display all data using 3-D graphic representations of all mechanical equipment.
- 5.13.2 Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 seconds.
- 5.13.3 Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 seconds and shall automatically refresh every 15 seconds
- 5.13.4 Colour graphic displays detailing hierarchical structure of facility, including floor plans, with multi-level penetration to equipment level.
- 5.13.5 System shall be capable of displaying graphic file, text, and dynamic object data together on each display. Information shall be labelled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user. Terminal shall allow user to change all field-resident BAS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.
- 5.13.6 All displays shall be generated and customized in such a manner that they fit the project as specified. Canned displays shall not be acceptable. Displays shall use standard English for labelling and readout. Systems requiring factory programming for graphics or DDC logic are specifically prohibited. The installing contractor without factory dependency or assistance shall support all graphics and DDC programming locally.
- 5.13.7 Binary objects shall be displayed as ON/OFF/NULL or with customized text. Text shall be justified left, right or centre as selected by the user. Also, allow binary objects to be displayed as individual change-of-state bitmap objects on the display screen such that they overlay the system graphic. Each binary object displayed in this manner shall be assigned up to three bitmap files for display when the point is ON, OFF or in alarm. For binary outputs, toggle the objects commanded status when the bitmap is selected with the system digitizer (mouse). Similarly, allow the terminal operator to toggle the object's status by selecting (with the mouse) a picture of a switch or light, for example, which then displays a different picture (such as an ON switch or lighted lamp). Additionally, allow binary objects to be displayed as an animated graphic.
- 5.13.8 Animated graphic objects shall be displayed as a sequence of multiple bitmaps to simulate motion. For example: when a pump is in the OFF condition, display a stationary picture of the pump. When the operator selects the pump picture with the mouse, the represented objects status is toggled and the picture of the pumps impeller rotates in a time-based animation. The operator shall be able to click on an animated graphical object or switch it from the OFF position to ON, or ON to OFF. Allow operator to change bitmap file assignment and also create new and original bitmaps online. System shall be supplied with a library of standard bitmaps, which may be used unaltered or modified by the operator. Systems that do not allow customisation or creation of new bitmap objects by the operator (or with third-party software) shall not be allowed.
- 5.13.9 Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual bitmap items on the display screen as an overlay to the system graphic. Each analog input object may be assigned to a minimum of five bitmap files, each with high/low limits for automatic selection and display of the bitmaps. As an example, a graphic representation of a thermometer would rise and fall in response to either the room temperature or its deviation from the controlling setpoint. Analog output objects, when selected with the mouse, shall be displayed as a prompted dialog (text only) box. Selection for display type shall be individual for each object. Analog object values may be changed by selecting either the increase or decrease arrow in the analog object spinner box without using the keypad. Pressing the button on the right side of the analog object spinner box allows direct entry of an analog value and accesses various menus where the analog value may be used, such as trendlogs.

- 5.13.10 Analog objects may also be assigned to an area of a system graphic, where the colour of the defined area would change based on the analog objects value. For example, an area of a floor-plan graphic served by a single control zone would change colour with respect to the temperature of the zone or its deviation from setpoint. All editing and area assignment shall be created or modified online using simple icon tools.
- 5.13.11 A customized menu label (push-button) shall be used for display selection. Menu items on a display shall allow penetration to lower level displays or additional menus. Dynamic point information and menu label push buttons may be mixed on the same display to allow sub-displays to exist for each item. Each display may be protected from viewing unless operator has appropriate security level. A separate security level may be assigned to each display and system object.
- 5.13.12 A mouse, or other form of digitizer, shall be used to move the pointer arrow to the desired item for selection of new display or to allow the operator to make changes to object data.
- 5.13.13 Displays may be modified on site or via remote communications.
- 5.13.14 Entire system shall operate without dependency on the operator's terminal. Provide graphic generation software at each workstation.

5.14 ALARMS

- 5.14.1 Operator's terminal shall provide audible, visual, and printed means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s), currently running (such as a word processor). Printout of alarms shall be sent to the assigned terminal and port.
- 5.14.2 System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal. Each entry shall include a description of the event-initiating object generating the alarm, time and date of alarm occurrence, time and date of object state return to normal, and time and date of alarm acknowledgement.
- 5.14.3 Alarm messages shall be in user-definable text English (or other specified language) and shall be entered either at the operator's terminal or via remote communication.

5.15 SCHEDULING

- 5.15.1 Operator's terminal display of weekly schedules shall show all information in easy-to-read 7-day (weekly) format for each schedule. This includes all ON/OFF times (to the minute) for each days events.
- 5.15.2 Exception schedules (non-normal schedules, such as holidays or special events) shall display all dates that are an exception to the weekly schedules. These speciality schedules shall be displayed at the operator's terminal in a format similar to the weekly schedules, again allowing easy data entry. Exception schedule data is entered by the following methods: date entries (one day entries), date-to-date (a range or span of days), and by weekday (for example, a given day of a given week each month). User shall be able to scroll easily through the months for each year as a minimum.
- 5.15.3 At the operator's terminal, the system user shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.

5.16 ARCHIVING

- 5.16.1 Store back-up copies of all controllers databases in at least one OWS and/or the server(if applicable).
- 5.16.2 Provide continuous supervision of integrity of all controller databases. If controller loses database, system to automatically download new copy of database to restore proper operation.
- 5.16.3 Data base back up and downloading to occur over LAN without operator intervention. Operator to be able to manually download entire controller database or parts thereof.

5.17 REPORTS

- 5.17.1 Provide a report facility to generate and format for display, printing, or permanent storage, as selected by the operator, the reports as specified in this section. If display output (CRT) is requested, it shall be scrollable; scroll bars will be used to allow easy and flexible movement within the report. Output to be sorted by area, system, point.
- 5.17.2 Periodic/Automatic Report: Provide the software to automatically generate any report specified, the user will be able to specify the type of report, start time and date, interval between reports (hourly, daily, weekly, monthly) and output device. The software will allow the operator to modify the periodic/automatic reporting profile at any time.
- 5.17.3 As a minimum, the following reports shall be configured on the system:
 - 5.17.3.1 Dynamic Reports: To allow operator to request a display of the dynamic value for the user specified points which shall indicate the status at the time the request was entered and updated at an operator modifiable scan frequency. It shall be possible to select points on the following basis:
 - 5.17.3.1.1 All points in all areas
 - 5.17.3.1.2 Area (all points in area)
 - 5.17.3.1.3 Area system (all points in system)
 - 5.17.3.1.4 Area system point (individual point)
 - 5.17.3.1.5 System (all points by system and point type)
 - 5.17.3.1.6 System point (all points by system and point type)
 - 5.17.3.1.7 Area point (all points by area and point type).
 - 5.17.3.2 Summary Report: To permit the display or printing the dynamic value for the user specified points which shall indicate the status at the time the CLM was entered. Reports to be available on same basis as dynamic reports. Output will be to the user selected output device.
 - 5.17.3.3 Trend Reports: To permit the trending of points selected by the operator, including as a minimum digital input and output, analog input and output, set points, and calculated values.
 - 5.17.3.4 Historical Data Collection: Provision shall be made to ensure historical data is not lost. The ability to off-load historical data to removable media, and to later load data previously backed-up, will be provided. Historical data values, for an operator specified time range and for operator specified points, may be output the same as for trend data.
 - 5.17.3.5 Critical Alarm Summary: Provide a summary of those points in the critical alarm state and include as a minimum; point acronym, point description, alarm type, limit exceed, current value, alarm type, time and date of occurrence.
 - 5.17.3.6 Maintenance Alarm Summary: Provide a summary of those points in maintenance alarm and include as a minimum; point acronym, point description, current value, alarm type, limit exceed, time and date of occurrence.

5.17.3.7 Alarm Summary: Provide a summary of all points in alarm and include as a minimum; point acronym, point description, current value, alarm type, limit exceeded, and time and date of occurrence.

5.17.3.8 Disable Point Summary: Provide a summary of all points in the disabled state and include as a minimum point acronym and point description.

5.17.3.9 Run Time Summary: Provide a summary of the accumulated running time of selected pieces of equipment with point acronym and description, run time to date, alarm limit setting. The run time shall continue to accumulate until reset individually by means of suitable operator selection.

5.17.3.10 Schedule Summary: Provide a summary of all schedules and indicate as a minimum, which days are holidays and, for each section, the day of the week, the schedule times and associated values; for digital schedules value will be on or off; for analog schedules value will be an analog value.

5.17.3.11 User Record Summary: Provide a summary of all user records to include as a minimum; user name, password, initials, command access level and point groups assigned.

5.18 UTILITY SOFTWARE

5.18.1 Supply and install software products to allow the owner to access and manipulate the control schematic diagrams, and to access product data sheets in an electronic format.

5.18.2 Enter all soft copy submissions; including "Record" drawings as specified herein [Shop Drawings, Product Data, etc.] in OWS.

5.19 WEB BROWSER CLIENTS

5.19.1 The system shall be capable of supporting at least 100 simultaneous users using a standard Web browser such as Internet Explorer. Systems requiring additional software to be resident on the client machine to enable a standard Web browser, or manufacturer-specific browsers shall not be acceptable.

5.19.2 The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BAS, shall not be acceptable.

5.19.3 The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

5.19.4 The Web browser client shall support as a minimum, the following functions:

5.19.4.1 User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

5.19.4.2 Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the Software shall be supported by the Web browser interface.

- 5.19.4.3 HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
- 5.19.4.4 Storage of the graphical screens shall be in the Network Control Unit (NCU), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
- 5.19.4.5 Real-time values displayed on a Web page shall update automatically without requiring a manual refresh of the Web page.
- 5.19.5 User's shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - 5.19.5.1 Modify common application objects, such as schedules, calendars, and set points in a graphical manner. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 - 5.19.5.1.1 Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 - 5.19.5.1.2 View logs and charts
 - 5.19.5.1.3 View and acknowledge alarms
 - 5.19.5.1.4 Setup and execute SQL queries on log and archive information
- 5.19.6 The system shall provide the capability to specify a user's home page (as determined by the log-on user identification). Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
- 5.19.7 Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Chilled water piping system.

1.2.1.2 Space heating hot water piping system.

1.2.1.3 Chilled glycol piping system.

1.2.1.4 Heating glycol piping system.

1.2.1.5 Condenser water piping system.

1.2.1.6 Condensate drainage system.

1.2.1.7 Chemical feed system.

1.2.2 Refer to Section 20 25 00 – Water Treatment for flushing, cleaning and chemical treatment.

1.2.3 Refer to Section 22 11 19 – Domestic Water Piping Specialties for backflow preventers.

1.3 REGULATORY REQUIREMENTS

1.3.1 In addition to specific requirements for pipe fittings as further specified in this document and where applicable, the equipment shall comply with the Boiler and Pressure Vessels Act (the “Act”) and CSA Standard B51.

1.3.2 In compliance with the Act and relevant Codes, all fittings shall be registered by the manufacturer, and shall be identified by the appropriate Canadian registration number.

1.3.3 Where fittings are provided without the appropriate Canadian registration number, the Contractor shall obtain a copy of the manufacturer's Statutory Declaration as provided to the authorities

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having jurisdiction.

1.3.4 All welding and fabrication shall be to the requirements of the ANSI/ASME B31.9 code for pressure piping and CSA standard B51 code for the Construction and Inspection of Boilers and Pressure Vessels.

1.3.5 All copper piping shall be certified to ASTM Standard B88 for Seamless Copper Water Tube.

2 **PRODUCTS**

2.1 PIPE AND FITTINGS

2.1.1 For 860 kPa (125 psi) or lower operating pressure use Class 125 fittings. For 860 kPa to 1,172 kPa (125 psi to 170 psi) operating pressure use Class 150 fittings. For 1,172 kPa to 3,034 kPa (170 psi to 440 psi) operating pressure use Class 300 fittings.

2.1.2 Heating water, chilled water, condenser water, and glycol piping shall be Schedule 40 black steel pipe; stretch reduced continuous weld, ASTM A53. Alternatively, soldered type 'L' copper pipe may be used for heating water and chilled water piping 50mm (2") diameter and smaller, for systems with operating pressures 240 psi or below.

2.1.3 Condensate drain piping shall be type DWV copper drainage tube with cast brass fittings and 50/50 solder joints. Provide screwed cleanout tees and crosses at all changes in direction.

2.1.4 Mechanical couplings (e.g. Victaulic) shall be permitted for heating, chilled and condenser water, and glycol systems, provided:

2.1.4.1 The couplings are located in accessible locations, unless otherwise approved by the engineer.

2.1.4.2 All couplings and fittings are by one manufacturer, suitable for pressure and temperature of respective system.

2.1.4.3 Rigid (Victaulic Style 107H Quick-Vic) couplings with offsetting angle bolt pads and AGS rigid couplings (Victaulic Style W07) are used in mechanical rooms.

2.1.4.4 Flexible (Victaulic Style 177 or AGS Style W77) couplings may be used in equipment drops in lieu of flexible connectors and where vibration attenuation and stress relief are required.

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- 2.1.4.5 Couplings for Schedule 40 piping to be manufactured from two (2) ductile iron housings conforming to ASTM-A536 and be complete with a Grade 'EHP' EPDM gasket, suitable for water service to 121°C (250°F). Flange adapters for sizes DN50 (2") to DN300 (12") to be ductile iron ASTM-A536, Victaulic Style 741. Flange adapters for sizes DN350 (14") to DN750 (30") shall be Victaulic W741 or W45R flanged adapter nipple with AGS grooved end.
- 2.1.4.6 Fittings for Schedule 40 piping shall be manufactured from ductile iron conforming to ASTM-A536, wrought steel conforming to ASTM-A234, or segmentally welded from steel pipe conforming to ASTM-A53, with grooves designed to accept grooved end couplings.

3 **EXECUTION**

3.1 GENERAL

- 3.1.1 Ream all piping and keep plugged to prevent entry of dirt. Use pipes, which conform to CSA and ASTM standards.
- 3.1.2 Cut true and thoroughly ream all pipe before installation.
- 3.1.3 Install all piping in the best professional manner and in accordance with the best practices of the trade.
- 3.1.4 Install piping so that there is no interference with the installation of equipment, other piping, systems, ducts or the work of other Subcontractors.
- 3.1.5 Consider the piping shown on the Drawings as diagrammatic, for clearness in indicating the general runs and connections and that the piping may, or may not, in all parts be shown in the true position. This does not relieve the Contractor's responsibility for the proper erection of the systems of piping in every respect suitable for the work intended.
- 3.1.6 Install piping in designated spaces, shafts, and chases. Space and arrange piping to best utilize available space. Arrange grouped valves in equally spaced steps or in straight rows.
- 3.1.7 Layout and install piping, valves, fittings and cleanouts to facilitate easy maintenance. Install valves and control devices in locations where they can be reached from the floor, platform, or an 2.4m (8 ft) high stepladder. The maximum reach allowed to operate and to service any device shall be 600mm (24"). Do not locate any

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valves, couplings, or flanged/union connections directly above electrical panels, motor starters or MCCs.

- 3.1.8 Install control valves with stems in vertical position with adequate clearance for removal of actuators.
- 3.1.9 Install eccentric reducers in all reductions of piping size. Maintain level on the top of pipes for water services and on bottom of pipe for steam. Provide proper venting and drainage.
- 3.1.10 Traps and fittings shall be of the same material, quality, and thickness as the piping to which they are attached.
- 3.1.11 Ensure that welding is performed, using either gas or electric welding equipment. Thoroughly clean pipe surfaces and level the ends of each pipe and fitting before welding. Securely align and space piping so that the width of circumferential welds is two and one-half times the pipe wall thickness. Ensure that the deposited metal forms a gradual increase in thickness from the outside surface to the centre of the weld.
- 3.1.12 Ensure that the pipe welding is done by a welder holding a certificate from TSSA or from the Canadian Welding Bureau (CWB) for the class of piping to be welded.
- 3.1.13 When welding or cutting with a torch, take every precaution to prevent fire. Ensure that welding or torch cutting operators have a fully charged 4.5kg (10 lb.) carbon dioxide fire extinguisher with them, when welding or cutting in building, or tunnels. Protect wooden structures with asbestos blanket.
- 3.1.14 Ensure that fabrication, welded or otherwise, meets the requirements of the ASA B31.9 Code for Pressure Piping, the CSA B51 Code for Boiler, Pressure Vessel, and Pressure Piping, and all requirements of the Boilers and Pressure Vessels Act of the Province of Ontario.
- 3.1.15 Use only fittings, or other materials to be incorporated in the work, which are approved by TSSA's Boiler and Pressure Vessels Safety Program, for the class of work for which they are used.
- 3.1.16 Thoroughly clean the inside of fittings and outside of pipe with steel wool and coat with flux, before soldering any copper pipe work joint. Remove the working parts of valves before soldering commences, and replace after soldering is complete.

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- 3.1.17 Provide swing joints in runouts to units, off horizontal mains.
- 3.1.18 Maintain minimum 25mm (1") space between adjacent flanges or pipe insulation (whichever has the largest diameter).
- 3.1.19 All buried steel piping shall be protected with Insul-mastic Eastern Ltd. coal tar epoxy and wrapped with Polyken tape. Overlap joints and seams 50mm (2") and double cover at elbows and fittings.
- 3.1.20 Provide full size flushing ports with valves of DN40 (1-1/2") size at the lowest point in each system with a vent at the high point. Grade piping and/or add additional valved and capped drain points to permit complete drainage of entire system.
- 3.1.21 Provide unions or flanges at all connections to equipment or fixtures requiring servicing or replacement. Provide Van Stone style flanges where applicable.
- 3.1.21.1 Unions or flanges for servicing are not required in installations using Victaulic couplings. (The couplings shall serve as disconnect points.)
- 3.1.22 All capped connections for piping DN65 (2-1/2") or larger shall be terminated with flange and blind flange.
- 3.2 **PIPE AND FITTINGS**
- 3.2.1 Piping DN65 (2-1/2") dia. and larger shall be welded using 'Weld-O-Lets', Victaulic Mechanical-T, or factory manufactured tees. Piping DN50 (2") dia. and smaller shall be screwed with cast iron fittings. Long radius forged welding elbows shall be used at all turns unless approved by the engineer.
- 3.2.2 Branch piping two sizes smaller than the main may be cut directly into the main and welded or hole-cut with Victaulic Mechanical-T fittings.
- 3.2.3 Provide screwed clean-out tees and crosses at all changes in direction of condensate drain piping.
- 3.2.4 Provide di-electric connections for cathodic protection wherever pipes of dissimilar material are connected together (Victaulic Style 47 Di-electric Waterway).
- 3.2.5 In copper pipes, provide wrought copper unions with soldered joints for pipe up to and including DN50 (2"), and 1,035 kPa (150 psi) cast brass flanges for pipes DN65 (2-1/2") or larger.

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3.2.6 Install all grooved end components as per manufacturers' latest recommendation. All grooved products shall be of one manufacturer. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products.

3.2.7 Provide valve bypass arrangement for water differential pressure transmitters. Coordinate exact quantity and location with the Subcontractor responsible for the work of Division 25 – Integrated Automation.

3.3 VENTING

3.3.1 On all up-feed coils, radiation, etc. provide a screwdriver operated manual air vent at the high point.

3.3.2 At all high points of the piping system provide a valved automatic float air vent. Pipe discharge to floor drains or to janitor sink with DN15 (1/2") dia. tubing.

3.3.3 Main vents in mechanical room shall be high capacity, Sarco model 13W with DN10 (3/8") dia. discharge tubing piped to the hub drain.

3.4 DRAINS

3.4.1 Provide drains at all low points of all liquid carrying systems and at other locations shown on the Drawings.

3.4.2 Drains shall consist of a capped DN20 (3/4") threaded hose end valve and cap, location to allow easy connection of drain hose.

3.5 FLUSHING AND CLEANING

3.5.1 General

3.5.1.1 Inspect the systems, and remove any heavy debris and excessive oil and dirt.

3.5.1.2 Flush all completed systems with clear water at the highest

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obtainable pressure and velocity.

- 3.5.1.3 During flushing and cleaning, maintain all isolating and control valves in the open position.

3.6 WATER FILL

- 3.6.1 Provide each water system with an 'Armstrong' make-up water combination feeder consisting of backflow preventer stop and check valve, strainer, pressure reducing valve, pressure gauge, and full sized quick fill by-pass.

- 3.6.2 Provide make-up water connections with shut-off valve to all equipment requiring same, such as boilers, cooling towers, etc.

3.7 TESTS

- 3.7.1 After all pipes have been placed in position, the tightness of all joints and the soundness of all pipes shall be tested as follows:

- 3.7.1.1 Test all water piping with cold water at a pressure of 1-½ times the working pressure, but not less than 1,035 kPa (150 psi), for a period of not less than four (4) hours, without any drop in pressure.

- 3.7.1.2 Any leaks found shall be made tight while under pressure. If this is not possible, piping shall be removed, refitted, and retested. Caulking of threaded joints shall not be accepted.

3.8 COMPLETION

- 3.8.1 Provide a declaration, signed by a responsible officer of the Division 23 – HVAC Subcontractor indicating that the following procedures and tests have been performed in accordance with the drawings and specifications. Provide two (2) copies of the signed declaration to the Consultant.

- 3.8.1.1 Water pressure test performed and leak free.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All hydronic specialties.

1.3 SHOP DRAWINGS

1.3.1 Submit shop drawings for the following equipment:

1.3.1.1 Strainers

1.3.1.2 Air separators

1.3.1.3 Expansion tanks

1.3.1.4 Hydraulic separators

1.3.1.5 BTU meters

2 **PRODUCTS**

2.1 STRAINERS

2.1.1 Provide Y or T type strainers as noted with stainless steel screen. For strainers in copper pipe, provide bronze body type. For other strainers provide ductile-iron (ASTM A536 Grade 65-45-12); semi-steel (ASTM A278 class 30); fabricated steel (ASTM A53 Grade B); or cast steel (ASTM A-216 WCB). Use screwed connections up to and including DN50 (2") and grooved or flanged connections for DN65 (2-½") and larger. Provide strainers of the self-cleaning type or with access to the basket for strainer maintenance.

2.1.2 Provide hose end valves for strainers at pump suction.

2.1.3 Provide stainless steel screens as follows:

2.1.3.1 Water service up to and including:

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DN50 (2")	20 mesh
DN65 (2-½"), DN80 (3") perforations	1.6mm (0.062")
DN100 – DN300 (4" – 12") and larger	3.2mm (1/8") perforations
DN350 – DN400 (14" – 16") perforations)	6 mesh (3.2mm
DN450 – DN600 (18" – 24")	4 mesh (5.2mm perforations)

- 2.1.4 For all strainers of the same type, furnish the same make.
- 2.1.5 Select strainer assemblies to suit the pressure and temperature of the application.
- 2.1.6 All strainers 50 mm (2") and larger shall be provided with blow down connection and valve.

2.2 EXPANSION TANKS

- 2.2.1 Air cushion tanks shall be galvanized steel pressurized air cushion bladder type, ASME-rated for 860 kPa (125 psi) and 115°C (240°F), maximum of size as shown on the drawings.
- 2.2.2 Each tank shall be complete with valved gauge glass, drain valve, cradles, support legs, and tapings.
- 2.2.3 Tank shall be replaceable bladder type, pre-pressurized, complete with a butyl bladder compatible with ethylene glycol.
- 2.2.4 Tank shall be vertical configuration, with an aerated skirt and a bottom connection through the skirt.

2.3 AIR SEPARATORS

- 2.3.1 Provide line size vortex air separators equal to S.A. Armstrong Model VA.

2.4 HYDRAULIC SEPARATORS

- 2.4.1 Provide line size Caleffi 4-in-1 hydraulic separator Combination: 1. air, 2. hydraulic and 3. dirt separation, plus 4. magnetic separation. Complete with: automatic air vent (code 501502A); air vent shut-off valve (code NA39589); 1" drain valve NA39753 (2"— 4" sizes) or 1 1/4" drain valve NA39588 (5"—6" sizes). Stainless steel internal

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coalescing mesh. One neodymium magnet assembly. Working temp. w/o insulation: 32—270°F. Pre-formed insulation on 2"—4" sizes. Connection: 4" ANSI 150 flange. Maximum working pressure: 150 psi. Medium temperature range: 32–220 °F.

2.5 **BTU METERS**

2.5.1 Provide Badger Meter SDI series flow sensor complete with data industrial 340 BN/MV BTU energy transmitter, or approved equal.

2.5.2 Provide remote reading totalizer complete with wiring and plastic conduit.

3 **EXECUTION**

3.1 **DRAIN PANS**

3.1.1 Construct drain pans of galvanized, min. 1.0mm (20-Ga.) sheet with sealed connections. Connect the drain lines to the nearest hub drain or janitor's sink.

3.1.2 Provide drain pans in the following locations:

3.1.2.1 Beneath all pipes passing through Electrical, Battery, Transformer, UPS, Computer and Telephone Rooms and over horizontal runs at bus duct.

3.2 **STRAINERS**

3.2.1 Provide strainers:

3.2.1.1 In the suction line of all pumps, (except where noted otherwise).

3.2.1.2 Upstream of automatic valves as indicated in plans, schedules, or flow diagrams.

3.2.1.3 Upstream of all pressure reducing valves.

3.2.1.4 Upstream of plate-and-frame heat exchangers (hot and cold sides).

3.2.1.5 Everywhere else as shown or detailed.

3.3 **EQUIPMENT CONNECTIONS**

3.3.1 Install piping connection to equipment, to prevent any strain on pipe and equipment and to facilitate removal equipment without disconnecting more than the minimum of pipework or shutting

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down any other piece of equipment.

3.3.2 Install equipment and apparatus requiring servicing and/or replacing with unions or flanges.

3.3.2.1 Unions or flanges for servicing are not required in installations using Victaulic couplings. (The couplings shall serve as disconnect points.)

3.3.3 Install valves, and automatic valve assemblies prefabricated and in uniform arrangement.

3.3.4 Install piping, automatic control valves, thermostat wells, orifice plates, etc., and any other appurtenances, supplied under other Sections of this Specification or by the Owner for insertion in piping and equipment.

3.3.5 Provide di-electric fittings between dissimilar metals where corrosion may occur.

3.4 EXPANSION TANKS

3.4.1 Mount tanks on floor where shown on the Drawings.

3.4.2 Refer to the Expansion Tank Schedule for tank sizes.

3.4.3 Piping from the system to the tank shall include an isolating valve and boiler drain. Pipe drain to nearest hub or funnel floor drain.

3.4.4 For tanks over 600mm (24") diameter, provide TSSA's Boilers and Pressure Vessels Safety Program Certificates and inspection openings.

3.5 HYDRAULIC SEPARATORS

3.5.1 Wall mount hydraulic separator in the mechanical room as shown on the Drawings.

3.5.2 Piping from the system to the separator shall include isolating valves and drain. Pipe drain to nearest hub or funnel floor drain.

3.6 BTU METERS

3.6.1 Connect meters to metering system. Refer to and coordinate with Div. 26 for metering system. Provide all necessary components for a complete and functional metering system.

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END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Space heating hot water pumps.

1.2.1.2 Condenser water pumps.

1.2.1.3 Glycol heating pumps.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for hydronic pumps.

1.3.2 Product data shall indicate dimensions, weights, capacities, ratings, pump performance, motor electrical characteristics, construction details, and finishes of materials.

1.3.3 Shop drawings shall indicate required clearances, isolation base detail, isolator selection, field connection details, lifting lug details.

1.3.4 Provide pump curves with specified operating point clearly plotted.

1.3.5 Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

1.3.6 Submit manufacturer's recommended installation instructions.

1.3.7 Submit letter from manufacturer(s) of hydronic pumps certifying that they have been installed in accordance with their recommendations.

2 **PRODUCTS**

2.1 VERTICAL IN-LINE CENTRIFUGAL

2.1.1 Provide vertical in-line, bronze fitted, single stage centrifugal

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pumps. Pumps shall be complete with mechanical seals, factory installed coupling guards, and permit maintenance without removal from line or major disassembly.

2.1.2 Pump

2.1.2.1 Up to and including 2.2 kW (3 hp) pumps shall be close coupled.

2.1.2.2 Over 2.2 kW (3 hp) pump shall be split coupled. Coupling shall be protected with a guard.

2.1.3 PUMP CASING

2.1.3.1 Cast iron for working pressure and temperature below 1,208 kPa (175 psi) and 66°C (150°F) with 860 kPa (125 psi) ANSI flange rating, and ductile iron for working pressures above 1,200 kPa (175 psi) with 1,723 kPa (250 psi) ANSI flange rating.

2.1.3.2 Flanged or grooved suction and discharge connections.

2.1.3.3 Bronze replaceable wear ring.

2.1.3.4 Install pressure taps on suction and discharge flanges, and mechanical seal flush connection.

2.1.3.5 Pumps and mechanical seals to be suitable for operation at 125% of scheduled temperature and pressure.

2.1.4 Impeller

2.1.4.1 Bronze enclosed, statically and dynamically balanced.

2.1.4.2 Diameter not more than 90% of maximum impeller diameter which casing can accommodate.

2.1.4.3 Mounted on stainless steel shaft.

2.1.5 Seals

2.1.5.1 Mechanical seals for close-coupled type pumps shall have inside type, single spring design, with carbon rotating face, Ni-resist seat, EPDM secondary seal, and stainless steel spring. For temperatures above 107°C (225°F), and/or stuffing box pressures above 1,208 kPa (175 psi) supply Tungsten Carbide seat. Provide vent line from seal chamber to pump suction.

2.1.5.2 Mechanical seals for split coupled type pump shall be multiple

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spring type, balanced, outside type with Durchrome rotating face, carbon stationary seat Viton secondary seal and alloy 20 springs. Bronze gland plate with stainless steel gland bolts shall secure stationary seat. Seat secured by 'C' clips only is not acceptable. For temperatures above 94°C (200°F) and/or stuffing box pressures above 1,553 kPa (225 psi), supply Tungsten Carbide rotating face. Provide factory installed flush line with manual vent. Supply on the flush line to the mechanical seal a 50-micron cartridge filter and floating ball type sight flow indicator to suit working pressure encountered. For differential pressures above 207 kPa (30 psi), or where indicated on pump schedule provide a Cyclone separator instead of 50 micron filter.

- 2.1.6 Motor
- 2.1.6.1 NEMA high efficiency ODP vertical electric motor.
- 2.1.6.2 Sized for continuous operation without exceeding horsepower rating, exclusive of service factor, at design capacity and head.
- 2.1.6.3 One-piece steel shaft with bronze shaft sleeve.
- 2.1.7 Submit pump curves showing operating characteristics and ratings. Submit pump curves showing parallel pump operation where applicable.
- 2.1.8 Pumps in parallel – provide pumps with rising head characteristics to shutoff.
- 2.2 VARIABLE SPEED VERTICAL-IN-LINE PUMPING UNITS
- 2.2.1 General
- 2.2.1.1 Provide Armstrong Series 4300 IVS (IVS Sensorless) split-coupled type Vertical In-Line HVAC pumping units, with rigid spacer type couplings and supplied with NEMA Premium efficiency motors and Armstrong NEMA/UL type-12 enclosure integrated controls. NEMA/UL type 1 enclosure is not acceptable for integrated controls. Refer to pump schedule for pump flows and heads and motor speed, enclosure and power requirements and other system conditions.
- 2.2.1.2 The controls shall be integrated with the pumping unit to 75hp/55kW motor size for a self-contained pump, motor and integrated controls combination to ensure optimum component matching and protection from motor overloading at any operating

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point. The pumping package shall be labeled with ETL listing certification that the product conforms to UL Std 778 and is certified to CSA Std C22.2 No.108. Controls for motors above 75hp/55kW will be supplied as separate items

- 2.2.1.3 Pump Construction: Pump Casing - Cast Iron with ANSI-125 / PN16 flanges for working pressure to 175 psig (12 bar) at 150°F (65°C) or Ductile Iron with ANSI-250 / PN25 flanges for working pressures to 375 psig (25 bar) at 150°F (65°C). Suction and discharge connections shall be equally sized ANSI flanges, and shall be drilled and tapped for seal flush and gauge connections.
- 2.2.1.4 Impeller - Bronze, fully enclosed type. Dynamically balanced. Two-plane balancing is required where installed impeller diameter is less than 6 times the impeller width.
- 2.2.1.5 Shaft - Provide Stainless Steel pump shaft.
- 2.2.1.6 Coupling - Rigid spacer type of high tensile aluminum alloy with a fully enclosed ANSI B15.1 Sect 8 and OSHA 1910.219 compliant guard. Pump design must such that the mechanical seal is replaceable without disturbing the pump or motor.
- 2.2.1.7 Mechanical Seals - Shall be Stainless Steel multi-spring outside balanced type with Viton® secondary seal, carbon rotating face and silicon carbide stationary seat. Provide a 316 stainless steel gland plate.
- 2.2.2 Integrated Controls
 - 2.2.2.1 Armstrong controls shall be of the VVC-PWM type providing near unity displacement power factor at all loads and speeds without the need for external power factor correction capacitors. The controls shall incorporate DC link chokes for the reduction of mains borne harmonic currents to reduce the DC link ripple current thereby increasing the DC link capacitors lifetime. This shall be at least equivalent to a 5% input filter. The controls shall be UL and C-UL Listed & CE Marked showing compliance with both the EMC Directive 89/336/EEC and the Low Voltage Directive 72/23/EEC. RFI filters shall be incorporated within the controls to ensure it meets the emission and immunity requirements of EN61800-3 to the 1st Environment Class C1 (EN55011 unrestricted sales class B) and supports IEEE 519-1992 requirements. The controls and motor protection shall include: motor phase to phase fault, motor phase to ground fault, loss of supply phase, over voltage, under voltage, motor over temperature, inverter overload, over current.

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Over current is not allowed ensuring 4300IVS units will not overload the motor at any point in the operating range of the unit.

- 2.2.2.2 The controls shall incorporate an integrated graphical user interface that shall provide running and diagnostic information and identify faults and status in clear English language. Faults shall be logged / recorded for interrogation at a later date. It shall be possible to upload parameters from one control hardware into the non-volatile memory of a computer and download the parameters into other control requiring the same settings. The keypad shall incorporate Hand-Off-Auto pushbuttons to enable switching between BAS/BMS and manual control. The controls shall incorporate a USB port for direct connection to a PC and an RS485 connection with Modbus RTU protocol. Optional protocols available should include BACnet MS/TP and LonWorks.
- 2.2.2.3 Programmable skip frequencies and adjustable switching frequency must be available for noise / vibration control
- 2.2.2.4 For IVS Sensorless Control software shall be available in the IVS unit to provide automatic speed control in variable volume systems for duty or duty / standby pump control without the need for pump mounted (internal/external) or remotely mounted differential pressure feedback sensor. Control mode setting and minimum / maximum head set-points shall be set at the factory and be user adjustable via the inbuilt programming interface.
- 2.2.2.5 The controls shall have the following additional features:
 - 2.2.2.5.1 Sensorless override by BMS
 - 2.2.2.5.2 Armstrong IPS pump controller
 - 2.2.2.5.3 Manual pump control
 - 2.2.2.5.4 Closed loop PID control for a remote sensor
 - 2.2.2.5.5 Auto alarm reset
 - 2.2.2.5.6 Motor pre-heat function
 - 2.2.2.5.7 Six programmable digital inputs
 - 2.2.2.5.8 Two analogue inputs
 - 2.2.2.5.9 One programmable analogue / digital output

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- 2.2.2.5.10 Two volt-free contacts.
- 2.2.3 System Control
 - 2.2.3.1 The 4300 IVS (IVS Sensorless) pumping unit shall be capable of operating in any of the following control modes:
 - 2.2.3.1.1 Duty Pump & Standby pump with Sensorless Control
 - 2.2.3.1.2 Duty Pump & Standby pumps with Remote Sensor or building system (BAS/BMS) control
 - 2.2.3.1.3 Multiple Pump with Multiple Sensors System Control, such as Armstrong IPS Controller.
- 2.3 BASE MOUNTED CENTRIFUGAL
 - 2.3.1 Provide base mounted single suction bronze fitted, single stage centrifugal pumps.
 - 2.3.2 Pump Construction
 - 2.3.2.1 Cast iron casing axially split, with flanged suction and discharge connections, complete with replaceable bronze-wear rings.
 - 2.3.2.2 Carbon steel shaft with stainless steel shaft sleeve.
 - 2.3.2.3 Supply dust tight deep groove ball bearings, with permanently sealed grease type lubrication. Bearings shall be mounted in cartridge type housing, and be replaceable without opening the pump casing.
 - 2.3.2.4 Each seal chamber shall be fitted with cartridge type mechanical seal. The seal shall be stainless steel construction, with carbon vs Ni-Resist faces and Buna secondary seal. The mechanical seal, shaft sleeve and seal plate shall be removable as a single component.
 - 2.3.2.5 Bronze enclosed dynamically balanced impeller, sized for not more than 90% maximum impeller diameter which casing can accommodate.
 - 2.3.2.6 Pressure gauge taps on suction and discharge flanges.
 - 2.3.2.7 Coupling guard.
 - 2.3.2.8 Flexible coupling with back pullout feature to accommodate seal

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removal without removing pump casing from line.

2.3.2.9 Pumps and mechanical seal to be suitable for operation at 125% of scheduled temperature and pressure.

2.3.3 Motor

2.3.3.1 NEMA high efficiency ODP horizontal T frame ball bearing motor.

2.3.3.2 Sized for continuous operation without exceeding horsepower rating, exclusive of service factor at design capacity and head.

2.3.4 Submit pump curves showing operating characteristics and ratings.

2.3.5 Pumps in Parallel

2.3.5.1 Provide pumps with rising head characteristics to shutoff. Submit pump curves showing parallel operation.

2.4 IN-LINE CIRCULATORS

2.4.1 Circulators shall be in-line pumps of type and size as shown on the Drawings.

2.4.2 Pumps shall be cast iron body with cadmium-plated steel impeller, alloy steel shaft with copper sleeve, and carbon mechanical seal.

2.4.3 Motor shall be resiliently mounted on a steel support. Connection to pump shall be with spring flexible coupling. Motor shall be with internal overload protection.

3 **EXECUTION**

3.1 GENERAL REQUIREMENTS

3.1.1 Provide all pumps and install them in accordance with the requirements of the respective manufacturer.

3.1.2 Pumps provided in critical and ultra-critical noise areas shall be mounted on vibration isolation pads, and adjacent piping shall be suspended from spring hangers. Refer to Section 20 05 48 - Vibration Isolation.

3.1.3 Insure that the piping does not stress the pump casing because of misalignment.

3.1.4 After connections have been made, fill system before starting

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pumps. Do not run dry under any circumstances.

3.1.5 Support piping from building structure to prevent any strain on pump casings. Make final check for alignment of piping connections before pump connections are tightened.

3.1.6 Provide flushing lines for all mechanical seals, and pipe from the discharge to the system lines to insure circulation.

3.2 VERTICAL IN-LINE PUMPS

3.2.1 Install pedestal pipe supports under each elbow and suction strainer, complete with vibration isolation pads. Refer to Section 20 05 48 - Vibration Isolation. Adjust support to carry 10% of pump weight.

3.2.2 Install long radius elbow at suction and discharge of each pump. Alternatively, factory manufactured inlet suction guides are acceptable.

3.2.3 Combination shut-off, balancing and check valves with appropriate pressure rating are acceptable for use on the pump discharge piping.

3.3 BASE MOUNTED CENTRIFUGAL PUMPS

3.3.1 Align pumps prior to start-up.

3.3.2 Pipe drip pan tapped connection to nearest drain.

END OF SECTION

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- 3.10 Venting
- 3.11 Startup and Testing

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 REFERENCES

- 1.2.1 ANSI/ASME B16.3 - Malleable-Iron Threaded Fittings
- 1.2.2 ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings
- 1.2.3 ANSI/ASME 16.9 - Factory-made Wrought Steel Buttwelding Fittings
- 1.2.4 ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless
- 1.2.5 STM A105 - Specification for Forgings, Carbon Steel for Piping Components
- 1.2.6 ASTM A181 - Specifications for Forgings, Carbon Steel for General Purpose Piping
- 1.2.7 ASTM A197 - Specifications for Cupola Malleable Iron
- 1.2.8 ASTM A234 - Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- 1.2.9 ASTM A307 - Specifications for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
- 1.2.10 ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings.

1.3 SCOPE OF WORK

1.3.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.3.1.1 Steam piping, fittings, valves.

1.3.1.2 Condensate piping, fittings, valves.

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- 1.3.1.3 Steam traps.
- 1.3.1.4 Steam separators.
- 1.3.1.5 Strainers.
- 1.3.1.6 Steam pressure reducing valves.
- 1.3.1.7 Safety relief valves.
- 1.3.1.8 Flash tanks.
- 1.3.1.9 Condensate coolers.
- 1.3.1.10 Heat transfer skids.
- 1.3.1.11 Condensate pumps.
- 1.3.1.12 Air vents and vacuum breakers.

1.4 SUBMITTALS

- 1.4.1 Provide shop drawings for all components of the steam and condensate systems.
- 1.4.2 As a minimum provide the following information:
 - 1.4.2.1 Complete specifications.
 - 1.4.2.2 Product data sheets indicating rated capacities, weight.
 - 1.4.2.3 Physical outline dimension drawing showing required clearances, weights, and location and size of connection entries.
- 1.4.3 Provide manufacturer's certification letters. Refer to Section 20 00 00 – General Requirements.

2 **PRODUCTS**

2.1 PIPE AND FITTINGS

- 2.1.1 Provide pipes and fitting with pressure rating appropriate for the respective system operating pressure:
 - 2.1.1.1 For the incoming steam and condensate service (1,379 kPa / 200 psi and less) - Class 300.
 - 2.1.1.2 For high pressure steam and condensate distribution within the

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- building (689 kPa / 100 psi and less) – Class 150
- 2.1.1.3 For low pressure steam and condensate distribution within the building (69 kPa / 10 psi and less) – Class 125
- 2.1.2 Up to and including DN80 (3")
 - 2.1.2.1 For high pressure steam:
 - 2.1.2.1.1 Pipe to be seamless or ERW black carbon steel, conforming to ASTM A53 Grade B Schedule 40 for steam service, and Schedule 80 for condensate service.
 - 2.1.2.1.2 Fittings to be black malleable iron banded screwed fittings conforming to ASTM A197 and ANSI/ASME B16.3.
 - 2.1.2.1.3 Unions to be black malleable iron construction with screwed ends., brass to iron ground joint seat (Dart type).
 - 2.1.2.1.4 Plugs to be Class 3000 screwed, square head, machined from solid steel or forging, to ASTM A105 Grade 2.
 - 2.1.2.2 For low pressure steam:
 - 2.1.2.2.1 Pipe to be MED-L copper (conforming to ASTM B819) or stainless steel (conforming to ASTM A312) for steam service, and Schedule 80 for condensate service.
 - 2.1.2.2.2 Fittings to be MED-L copper (conforming to ASTM and ANSI) or stainless steel (conforming to ASTM A351 and ANSI) screwed fittings.
 - 2.1.2.2.3 Unions to be MED-L copper or stainless steel construction with screwed ends.
 - 2.1.2.2.4 Plugs to be Class 3000 screwed, square head, machined from MED-L copper (conforming to ASTM xxx) or stainless steel (conforming to ASTM A312).
- 2.1.3 DN100 (4") and larger
 - 2.1.3.1 For high pressure steam:
 - 2.1.3.2 Pipe to be Schedule 40 seamless or ERW black carbon steel, conforming to ASTM A53 Grade B, with beveled ends.
 - 2.1.3.3 Fittings to be Schedule 40 seamless carbon steel butt welding

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fittings conforming to ASTM A234 Grade WPB and ANSI/ASME B16.9.

- 2.1.3.4 Closures to be Schedule 40 seamless butt welding caps, carbon steel, conforming to ASTM A234 Grade B.
- 2.1.3.5 Gaskets to be 1.6mm (1/16") Garlock 3200 with SBR binder, or equivalent asbestos-free material manufactured by Anchor. Bolts to be semi-finished hex head machine bolts and semi-finished hex nuts, both of carbon steel conforming to ASTM A307 Class A.
- 2.1.3.6 For low pressure steam:
 - 2.1.3.6.1 Pipe to be MED-L copper or stainless steel with beveled ends.
 - 2.1.3.6.2 Fittings to be MED-L copper or stainless steel butt welding fittings conforming to ASTM A234 Grade WPB and ANSI/ASME B16.9.
 - 2.1.3.6.3 Closures to be MED-L copper or stainless steel butt welding caps, conforming to ASTM A234 Grade B.
 - 2.1.3.6.4 Gaskets to be 1.6mm (1/16") Garlock 3200 with SBR binder, or equivalent asbestos-free material manufactured by Anchor. Bolts to be semi-finished hex head machine bolts and semi-finished hex nuts, both of MED-L copper or stainless steel.
- 2.1.3.7 Flanges to be forged steel, slip-on or weld neck type, conforming to ASTM A181 Grade 1 and ANSI/ASME B16.5. Provide flat-faced flanges for connection to cast iron valves.

2.2 VALVES

2.2.1 General

- 2.2.1.1 All valves to be of one manufacture unless otherwise noted and should have the manufacturer's name and pressure rating clearly marked on the body. Valves to conform to the current of ANSI, ASTM, ASME, and applicable Manufacturer's Standardization Society Specification (MSS).
- 2.2.1.2 Bronze valves up to and including 1034kPa (150 psi) steam pressure to be manufactured to ASTM B62-93 standard. Bronze valves up to 1379kPa (200 psi) and 2068kPa (300 psi) steam pressure to be manufactured to ASTM B61-93 standard.
- 2.2.1.3 Iron body valves shall be ductile iron manufactured to ASTM A536-84 Grade 65-45-12 or cast iron ASTM A126-95 Class B standard

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where ductile iron is not available.

- 2.2.1.4 All valves shall have a CRN registration number.
- 2.2.1.5 Use gate and globe valves of a design, which permits the valve to be repacked under pressure, when fully open.
- 2.2.1.6 Provide valves with the manufacturer's name or trademark, figure number and pressure rating cast or stamped on the valve body or wheel handle.
- 2.2.1.7 Furnish iron body valves with renewable seats.
- 2.2.2 Valves for steam and condensate service up to 414 kPa (60 psi)
 - 2.2.2.1 Gate Valves (Isolation Service)
 - 2.2.2.1.1 DN 50 (2") dia. or less - shall be Class 125, all bronze, with solid wedge disc, rising stem.
 - Threaded ends
 - Toyo 293
 - Kitz 24
 - Crane 428
 - 2.2.2.1.2 For application where non-rising stem is required.
 - Threaded ends
 - Toyo 280A
 - Kitz 40
 - Crane 438
 - 2.2.2.1.3 DN 65 (2-½") dia. and over - shall be Class 125, iron body/bronze mounted, with O.S. & Y., solid wedge design.
 - Flanged ends
 - Toyo 421
 - Kitz 72
 - Jenkins Fig. 454J
 - Crane 465 ½
 - 2.2.2.1.4 For application where non-rising stem is required.
 - Flanged ends
 - Toyo 415
 - Kitz 75
 - Jenkins Fig. 452J
 - Crane 461
 - 2.2.2.2 Globe Valves (Throttling Service)

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- 2.2.2.2.1 DN 50 (2") dia. or less - shall be Class 125, all bronze, with rising stem, fitted with PTFE disc.
- Threaded ends - Toyo 220
 - Kitz 03
 - Crane 7TF
- 2.2.2.2.2 DN 65 (2-½") dia. and over - shall be Class 125, iron body/bronze mounted, O.S. & Y.
- Flanged ends - Toyo 400A
 - Kitz 76
 - Crane 351
- 2.2.2.3 Check Valves
- 2.2.2.3.1 DN 50 (2") dia. or less - shall be Class 125, all bronze, Y pattern swing check.
- Threaded ends - Toyo 236
 - Kitz 22
 - Crane 37
- 2.2.2.3.2 DN 65 (2-½") dia. and over - shall be Class 125, iron body/bronze mounted or stainless steel, with bolted bonnet.
- Flanged ends - Toyo 435A
 - Kitz 78
 - Jenkins Fig. 587J
 - Duo Check II (Wafer Style)
 - Mueller 71 series
 - Moygro (Wafer Style)
 - Crane 373
- 2.2.2.4 Ball Valves (Drain Service)
- 2.2.2.4.1 DN 50 (2") dia. or less - shall be rated for 1,724 kPa (250 psi) steam, with full port bronze body, stainless steel ball and stem, Multi-filled seats and packing.
- Threaded ends - Apollo 70-140-64
 - MAS BZ-3-SS-250
- 2.2.2.5 Butterfly Valves (Isolation Service)
- 2.2.2.5.1 DN 65 (2-½") dia. and up to DN 300 (12") dia. - shall be Class 150,

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carbon steel full lug body with stainless steel stems and disc, RTFE packing and seat, with a bi-directional shut off to the full ANSI rating.

2.2.2.5.2 Valves DN 50 (2") dia. and up to DN 100 (4") dia. shall have a 10-position lever. Valves DN 150 (6") dia. and above shall have hand wheel gear activator.

Lug Style - WKM B5-113-02-S02-11-HL/WG
 - Powell 1572QCRTXXXGLV/GXX

2.2.3 Valves for steam and condensate service up to 689 kPa (100 psi)

2.2.3.1 Gate Valves (Isolation Service)

2.2.3.1.1 DN 50 (2") dia. or less - shall be Class 800, forge steel body, with O.S. & Y., bolted bonnet, ½ Stellite trim, graphite packing.

- Bonney Forge HL-11-T (threaded ends)
- Bonney Forge HL-11-SW (socket weld)
- Beric 501-T(X)-8-A-08
- Beric 501-S(X)-8-A-08
- Powell GA08TA58GB (threaded ends)
- Powell GA08SA58GB (socket weld)

2.2.3.1.2 DN 65 (2-½") dia. and over - shall be Class 150, carbon steel body, with O.S. & Y., solid wedge design.

Flanged ends - Kitz 150SCLS
 - Beric 101-RF-AA08-H
 - Bonney Forge 1-11-RF
 - Powell 1503FC8G

Butt weld - Kitz W150SCLS
 - Beric 101-BW-AA08-H
 - Bonney Forge 1-11-BW
 - Powell 1503(X)C8G

2.2.3.2 Globe Valves (Throttling Service)

2.2.3.2.1 DN 50 (2") dia. or less - shall be Class 800, forge steel body, O.S. & Y., bolted bonnet, ½ Stellite trim, graphite packing.

- Bonney Forge HL-31-T (threaded ends)
- Bonney Forge HL-31-SW (socket weld)

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- Beric 502-T-(X)-8-A-08
- Beric 502-S-(X)-8-A-08
- Powell GL08TA8GB (threaded ends)
- Powell GL08TA8GB (socket weld)

2.2.3.2.2 DN 65 (2-½") dia. and over - shall be Class 150, carbon steel body, O.S. & Y.

- Flanged ends
- Kitz 150SCJS
 - Beric 201-RF-AA08-H
 - Bonney Forge 1-31-RF
 - Powell 1531FC8G

- Butt weld
- Kitz W150SCJS
 - Beric 201-BW-AA08-H
 - Bonney Forge 1-31-BW
 - Powell 1531(X)C8G

2.2.3.3 Check Valves

2.2.3.3.1 DN 50 (2") dia. or less - shall be swing type Class 800, forge steel body, with bolted bonnet, ½ Stellite trim, and graphite gasket.

- Threaded ends
- Bonney Forge HL-61-T
 - Beric 504-T-(X)-8-A-08
 - Powell SW08TA58GB

- Socket weld
- Bonney Forge HL-61-SW
 - Beric 504-S-(X)-8-A-08
 - Powell SW08SA58GB

2.2.3.3.2 DN 65 (2-½") dia. and over - shall be Class 150, carbon steel body, with bolted cover, ½ Stellite trim, graphite gasket.

- Flanged ends
- Kitz 150SCOS
 - Beric 301-RF-AA08-X
 - Bonney Forge 1-61-RF
 - Powell 1561FC8G

- Butt weld
- Kitz W150SCOS
 - Beric 301-BW-AA08-X
 - Bonney Forge 1-61-BW
 - Powell 1561(X)C8G

2.2.3.4 Ball Valves (Drain Service)

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- 2.2.3.4.1 DN 50 (2") dia. or less - shall be rated for 1,724 kPa (250 psi) steam, with 2-piece forged steel body, stainless steel ball and stem, Multi-filled seats and packing.
- Threaded ends - Apollo 73A-140-64
- MAS CSCR-2-250
- 2.2.3.5 Butterfly Valves (Isolation Service)
- 2.2.3.5.1 DN 65 (2-½") dia. and up to DN 300 (12") dia. - shall be Class 150, carbon steel full lug body with stainless steel stems and disc, RTFE packing and seat, with a bi-directional shut off to the full ANSI rating.
- 2.2.3.5.2 Valves DN 50 (2") dia. and up to DN 100 (4") dia. shall have a 10-position lever. Valves DN 150 (6") dia. and above shall have hand wheel gear activator.
- Lug Style - WKM B5-113-02-S02-11-HL/WG
- Powell 1572QCRTXXXGLV/GXX
- 2.2.4 Valves for steam and condensate service up to 1,379 kPa (200 psi)
- 2.2.4.1 Gate Valves (Isolation Service)
- 2.2.4.1.1 DN 50 (2") dia. or less - shall be Class 800, forge steel body, with O.S. & Y., bolted bonnet, ½ Stellite trim, graphite packing.
- Bonney Forge HL-11-T (threaded ends)
- Bonney Forge HL-11-SW (socket weld)
- Beric 504-T-(X)-8-A-08
- Beric 504-S-(X)-8-A-08
- Powell GA08TA58GB (threaded ends)
- Powell GA08SA58GB (socket weld)
- 2.2.4.1.2 DN 65 (2-½") dia. and over - shall be Class 300, carbon steel body, with bolted bonnet, O.S. & Y., ½ Stellite trim, graphite packing.
- Flanged ends - Kitz 300SCLS
- Beric 103-RF-AA08-H
- Bonney Forge 3-11-RF
- Powell 3003-FC8G
- Butt weld - Kitz W300SCLS
- Beric 103-BW-AA08-H

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- Bonney Forge 3-11-BW
- Powell 3003-(X)C8G

2.2.4.2 Globe Valves (Throttling Service)

2.2.4.2.1 DN 50 (2") dia. or less - shall be Class 800, forge steel body, O.S. & Y., bolted bonnet, ½ Stellite trim, graphite packing.

- Bonney Forge HL-31-T (threaded ends)
- Bonney Forge HL-31-SW (socket weld)
- Beric 502-T-(X)-8-A-08
- Beric 502-S-(X)-8-A-08
- Powell GL08TA58GB (threaded ends)
- Powell GL08SA58GB (socket weld)

2.2.4.2.2 DN 65 (2-½") dia. and over - shall be Class 300, carbon steel body, with bolted bonnet, O.S. & Y., ½ Stellite trim, graphite packing.

- Flanged ends
- Kitz 300SCJS
 - Beric 203-RF-AA08-H
 - Bonney Forge 3-31-RF
 - Powell 3031-FC8G

- Butt weld
- Kitz W300SCJS
 - Beric 203-BW-AA08-H
 - Bonney Forge 3-31-BW
 - Powell 3031(X)C8G

2.2.4.3 Check Valves

2.2.4.3.1 DN 50 (2") dia. or less - shall be swing type Class 800, forge steel body, with bolted bonnet, ½ Stellite trim, and graphite gasket.

- Threaded ends
- Bonney Forge HL-61-T
 - Beric 504-T-(X)-8-A-08
 - Powell SW08TA58GB

- Socket weld
- Bonney Forge HL-61-SW
 - Beric 504-S-(X)-8-A-08
 - Powell SW08TA58GB

2.2.4.3.2 DN 65 (2-½") dia. and over - shall be Class 300, carbon steel body, with bolted cover, ½ Stellite trim, graphite gasket.

- Flanged ends
- Kitz 300SCOS
 - Beric 303-RF-AA08-X

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- Bonney Forge 3-61-RF
- Powell 3061-FC8G

Butt weld

- Kitz W300SCOS
- Beric 303-BW-AA08-X
- Bonney Forge 3-61-BW
- Powell 3061-(X)C8G

2.2.4.4 Ball Valves (Drain Service)

2.2.4.4.1 DN 50 (2") dia. or less - shall be rated for 1,724 kPa (250 psi) steam, with 2-piece forged steel body, 316 stainless steel ball and stem, Multi-filled seats and packing.

- Threaded ends
- Apollo 73A-140-64
 - MAS CSCR-2-250

2.2.4.5 Butterfly Valves (Isolation Service)

2.2.4.5.1 DN 65 (2-½") dia. and up to DN 300 (12") dia. - shall be Class 300, carbon steel full lug body with 316 stainless steel seat and disc, bolted seat retainer, 17-4 stainless steel shaft, with a bi-directional Class IV shut off.

2.2.4.5.2 Valves DN 50 (2") dia. and up to DN 100 (4") dia. shall have a 10-position lever. Valves DN 150 (6") dia. and above shall have hand wheel gear activator.

- Lug Style
- WKM B5-313-02-M01-13-HL/WG
 - Powell 3072QCRTXXXGLV/GXX

2.3 STEAM FLOW METER

2.3.1 Provide Model 3095 MFC Mass Flow Meter as manufactured by Rosemount. The mass flow meter is to be comprised of the following equipment:

2.3.1.1 Compact Orifice Plate to produce differential pressure

2.3.1.2 Complete assembly including tubing, valves, adapters, manifold, centering ring, and mounting bracket

2.3.1.3 Comply to ASME/ ISO corner tap design

2.3.1.4 Assembly must include either a differential pressure transmitter for liquids or a fully compensated, multi-variable differential pressure, pressure and temperature transmitter for steam and gas

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- 2.3.1.5 Accuracy up to + 0.75% of volumetric flow rate for liquids and 0.70% of mass flow rate for steam and gas
- 2.3.1.6 Complete assembly require only two diameters of upstream and downstream piping or shall comply to ISO5167 recommended upstream and downstream pipe diameters
- 2.3.2 The instrument selected shall be suitable for the following conditions:
 - 2.3.2.1 Electronics Temperature Limits:
 - 2.3.2.1.1 -40 to 85 Degrees C (-40 to 185°F)
 - 2.3.2.2 Pressure Limits:
 - 2.3.2.2.1 Direct Mount Electronics:
 - Pressure Retention per ANSI B16.5 600# or DIN PN 100
 - 2.3.2.3 Process Conditions
 - 2.3.2.3.1 Suitable for liquid, gas and steam in homogeneous, single-phase state
 - 2.3.2.4 Process Temperature Limits:
 - 2.3.2.4.1 Direct Mount Electronics: 232 Degrees C (450°F)
 - 2.3.2.4.2 Remote Mount Electronics: 454 Degrees C (850°F)
 - 2.3.2.5 Electrical
 - 2.3.2.5.1 Flow meter shall be certified for use in hazardous areas by a recognized authority, such as the Canadian Standards Association (CSA).
 - 2.3.2.5.2 Electrical connections shall include a choice of: ½-14 NPT, M20 x 1.5 or PF13.5.
 - 2.3.2.6 Power Supply
 - 2.3.2.6.1 HART communication: flow meter shall operate (4-20mA) on 11 to 55vdc with no load.
 - 2.3.2.6.2 Foundation Fieldbus communication: flow meter shall operate on 9 to 32 Vdc, 17.8 mA nominal, 19 mA maximum.

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2.3.2.7 Line Sizes

2.3.2.7.1 Flow meter shall be available in the following line sizes:

- Compact Conditioning Orifice Plate: 2-, 3-, 4-, 6-, and 8-inch wafer style
- Compact Orifice Plate: ½-, 1-, 1 ½-, 2-, 3-, 4-, 6-, and 8-inch wafer style

2.3.2.7.2 An ANSI alignment ring shall be included for flange rating with ASME B16.5 (ANSI) Class 150, 300, 600, or DIN PN 16, 40, 100.

2.3.2.8 Outputs

2.3.2.8.1 Output shall be a 4-20 mA analogue signal with a superimposed HART digital signal.

2.3.2.8.2 Analogue output shall be adjustable remotely with a field communicator or a control system.

2.3.2.8.3 Foundation Fieldbus output also available.

2.4 STEAM SEPARATOR

2.4.1 Provide Armstrong Model DS-1 (DN 40 (1-½") – DN 50 (2") NPT) or DS-2 (DN65 (2-½") and larger) series steam separator. The body shall be of ductile iron construction.

2.4.2 Provide Class 300 threaded connections up to size DN 50 (2"). Provide Class 300 flanged connections for DN 65 (2-1/2") and over.

2.4.3 The separator will remove 99% of all entrained liquid and particles that are 10 microns and larger.

2.5 STEAM PRESSURE REDUCING VALVES (SELF CONTAINED PILOT)

2.5.1 Provide Armstrong Model GP2000 series, factory assembled and tested, self-contained, dead end shutoff (Class IV), pilot operated steam pressure reducing valves. The pilot valve shall be integrally mounted to main valve. The valve body shall be of ductile iron construction.

2.5.2 Provide Class 300 threaded connections up to size DN 50 (2"). Provide Class 150 or Class 300 flanged connections for DN 65 (2-

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1/2") and over.

2.5.3 The outlet pressure accuracy shall be +/- 1% from 5 to 100% of flow. The turndown ratio (pressure) shall be 20:1 and the rangeability (flow) shall be 20:1.

2.5.4 The valve shall be field adjustable to desired set pressure.

2.5.5 All working parts shall be renewable inline.

2.5.6 Provide valves with stainless steel internal trim, hardened stainless steel valve and seat and stainless steel main diaphragm.

2.6 SAFETY RELIEF VALVES

2.6.1 Provide safety relief valves as indicated on schedule and/or plans.

2.6.2 Provide Series 19, CRN registered factory tested safety relief valves for inlet sizes DN15 (1/2") to DN 50 (2"). Safety relief valves to be cast iron brass, bronze/Teflon trim, rated for 1,379 kPa (250 psi).

2.6.3 Provide Series 119, CRN registered factory tested safety relief valves for inlet sizes DN 65 (2-1/2") and larger. Safety relief valves to be cast iron, stainless steel trim, rated for 1,379 kPa (250 psi).

2.6.4 Safety relief valves to be certified with sealed setting to 110% of the system pressure.

2.6.5 Provide valves, which are capable of discharging the full rated capacity of the steam pressure-reducing valve, or valves located upstream.

2.6.6 Provide drip pan elbows on all valves whose outlet is DN 50 (2") or greater.

2.7 STEAM TRAPS

2.7.1 Traps shall be sized by manufacturers' representative according to models outlined in schedule using safety factors as outlined in specifications.

2.7.2 Provide Armstrong series 800 inverted bucket steam traps with ASTM A48 cast iron 1,379 kPa (250 psig) rated body. The trap shall employ a simple free-floating stainless steel valve mechanism with no fixed pivots and no valve or bucket guides. The discharge valve shall be so attached to the valve lever that it is free to rotate

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for even wear distribution, and the valve and seat of the trap shall be lapped together as a matched set to insure tight shutoff. The piping configuration for the trap shall be side inlet / side outlet.

- 2.7.3 Provide Armstrong 'B' series Float and Thermostatic steam traps with ASTM A48 cast iron 1,379 kPa (250 psig) rated body. The float, lever, and valve assemblies shall be of stainless steel. The trap shall incorporate a balanced pressure thermostatic air vent with a phosphor bronze bellows caged in stainless steel. The trap body shall be furnished with a plugged bottom drain connection and a tapped top port for the addition of an integral vacuum breaker.

2.8 STEAM TRAP MONITORING

- 2.8.1 Provide Armstrong model RC self-contained centralized trap monitoring system for all traps except flooded applications. Device to use radio frequency to send signal to a centralized receiver. If using a hard wired system, Mechanical Contractor to carry all electrical hook up costs.
- 2.8.2 Monitoring device to detect failed closed, failed open or operational conditions.
- 2.8.3 Monitoring device to be integral to trap. Separate sensing chambers are not acceptable.
- 2.8.4 Where required, use a repeater powered by 120V source to amplify the signal between the transmitter device and receiver.
- 2.8.5 Receiver assembly to be web-based and accessible through facilities internal network.

2.9 AIR VENTS AND VACUUM BREAKERS

- 2.9.1 Provide Armstrong model TV-2 pressured balanced thermostatic air vent at top of steam risers.
- 2.9.2 Provide Armstrong A5628 stainless steel vacuum breaker on all non-flooded modulated service apparatuses. Minimum vacuum required to open breaker to be 3.8mm (0.15") H.g.

2.10 FLASH TANKS

- 2.10.1 Provide series DFT vertical flash tanks. Tanks shall be constructed of mild steel to the current version of CSA B51 standards with ANSI Class 150 flanges for condensate inlet and

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flash outlet connections. Screwed end connections shall be provided for low-pressure condensate outlet, pressure gauge, and safety valve connections. The vessel shall be self-standing and be provided with legs, which have provision for securing to the flow with anchor bolts.

2.10.2 Flash tank shall be CRN registered rated for steam system pressure and shall come complete with pressure gauge, safety relief valve, and steam trap.

2.10.3 Provide flash tanks to meet the performance and operating conditions shown on the drawings.

2.11 CONDENSATE COOLERS

2.11.1 Self-contained model CC-5 manufactured by Armstrong complete with bronze bodied, stainless steel trim, proportional control cooling valve c/w sensor & capillary.

2.11.2 Condensate cooler body to be cast iron with connections for hot condensate, vent, cold water supply, and drain.

2.12 HEAT TRANSFER SKIDS

2.12.1 Heat transfer units to be pre-piped flooded design as manufactured by Preston Phipps.

2.12.2 Skid packages to include Fisher control valve to regulate liquid level within heat exchanger. Control valves to be stainless steel body as well as stainless steel trim. Control valves to be complete with electric actuator.

2.12.3 System to include panel mounted C-100 controller. Skid to be pre-wired with the exception of temperature transmitter, which is to be field wired. Temperature transmitter to be supplied by skid manufacturer. Controller shall have the ability to provide output temperature and valve position to the BAS. Controller shall be equipped with a dry contact enabling the closure of the steam supply valve on an external signal.

2.12.4 Heat exchanger to be plate and shell per model numbers described in Schedule.

2.12.5 Heat exchangers to be oversized by a minimum of 65% of design parameters outlined in schedule to maximize sensible heat extraction well beyond the 76.7°C (170°F) requirement.

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- 2.12.6 Packages to incorporate F & T type traps per section **Error! Reference source not found..**
- 2.12.7 Supply TVS4000 c/w 2011 inverted bucket trap (shipped loose) to be installed at steam supply inlet of skid. See typical layout drawing.
- 2.12.8 Piping within skid to be Schedule 80.
- 2.12.9 Pressure/temperature ratings to be 1,724 kPa (250 psig) / 204°C (400°F) and skid assembly to be registered with TSSA.
- 2.13 MECHANICAL PUMPS
- 2.13.1 Provide Low Boy™ pre-piped mechanical pump receiver packages as manufactured by Armstrong, per schedule.
- 2.13.2 Low Boy™ pump capacities to be sized with 0mm (0") head due to height restrictions.
- 2.13.3 Pump trap body shall be constructed of cast iron or carbon steel with all stainless steel internals. The mechanism shall incorporate Inconel X-750 springs for a long service life. Springs made of materials other than Inconel shall not be accepted. Single compression spring shall not be accepted.
- 2.13.4 The pump traps shall utilize steam, compressed air or inert gas to remove condensate from the receiving vessel.
- 2.13.5 Factory package to include vented or CRN code carbon steel receiver sized in accordance with manufacturers guidelines. Connections shall include connections for condensate inlet, flash relief, overflow and condensate discharge.
- 2.13.6 Pump shall be pre-piped between the pump inlets and receiver outlet including isolation valves, stainless steel NPT check valves and unions.
- 2.13.7 Pumps shall require no electricity for operation.
- 2.13.8 The pump traps and receiver shall include a bronze water level gauge and shut off valves.
- 2.13.9 Provide pump traps with removable insulation cover.
- 2.13.10 Pump mechanism to have a 3-year unconditional warranty.

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3 EXECUTION

3.1 PIPING AND FITTINGS

- 3.1.1 Do not use DN 90 (3-½") and DN125 (5") pipe for piping systems covered by this Section.
- 3.1.2 Make reduction in steam mains by eccentric reducing couplings with bottom of pipes being in a level plane.
- 3.1.3 Take steam supply branches off top of main either vertically or at a 45-degree angle as space permits.

3.2 VALVES

- 3.2.1 Wherever possible, provide all valves supplied by one manufacturer.
- 3.2.2 Provide chain wheel operators and operating chain for all valves located more than 2.1m (7 ft) above floor or walkway.
- 3.2.3 Provide chain of sufficient length to extend to within 2.1m (7 ft) of operating platform or floor for free hanging chains, or to within 1.5m (5 ft) of floor in locations where chain can be secured to wall or column. Provide wall hook as required for securing chain to wall or column.
- 3.2.4 Provide chain wheels complete with guide, rustproof chain and of size recommended by the valve manufacturer for proper operation of the valve.
 - 3.2.4.1 Provide globe valves for preheat systems and by-pass temperature control valves.
 - 3.2.4.2 Provide check valves on the discharge of steam traps.

3.3 STEAM CONNECTIONS

- 3.3.1 Provide, at the connection to each piece of equipment, a globe or piston type isolation valve.
- 3.3.2 Provide a steam trap assembly in the condensate return piping from each piece of equipment, at the base of each riser, in horizontal steam mains at ends of mains, where indicated and detailed on drawings, as specified herein before, and wherever it is necessary to raise the piping to avoid a reduction in ceiling height or minimum headroom allowances. Equip each trap with shutoff

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valves, a strainer, and a dirt pocket.

- 3.3.3 Install the entire system of return line piping so that all condensate will be returned by gravity to the existing condensate system without water hammer.
- 3.3.4 Lifting of condensate for modulated service is not permitted unless indicated on drawings.
- 3.3.5 Provide air vents at all system high points.
- 3.3.6 Provide vacuum breakers in condensate outlet piping, after each temperature control valve to closed steam actuated vessels such as coils and heat exchangers, and in steam piping where required to control induced vacuum. This does not apply to flooded heat exchanger systems.

3.4 PRESSURE REDUCING VALVES

- 3.4.1 Provide safety relief valve on the low pressure side of the pressure reducing valve as indicated in schedule.
- 3.4.2 Immediately downstream from a pressure reducing valve, provide an eccentric increaser from the pressure reducing valve to line size.
- 3.4.3 Immediately upstream from a pressure reducing valve, reduce from line size to valve size using an eccentric reducing fitting.
- 3.4.4 Inlet strainer preceding pressure reducing valve shall be full in size located upstream of straight run into valve. The strainer shall be installed on its side to prevent condensate build-up. Interpret the expression "full line size" to be the pipe size of steam main for the applicable design pressure.
- 3.4.5 Install steam separators prior main PRV stations coming into the building.
- 3.4.6 Isolating gate valves shall be full line size located outside the straight run boundaries of a pressure reducing station.
- 3.4.7 Install all takeoffs for pressure sensing lines to meet manufacturers' instructions, but not less than 10 pipe diameters after any change in direction, branch, takeoff or valve.
- 3.4.8 Pressure sensing lines to pilot operated pressure reducing valves to be pitched down back towards steam line.

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3.4.9 All pressure gauges shall be installed with tubing loops to maintain liquid exposure to the gauge.

3.5 STEAM TRAPS

3.5.1 Provide Float and Thermostatic steam traps for modulating service of 207 kPa (30 psig) or less.

3.5.2 Provide Inverted Bucket steam traps for all drips, all constant pressure applications or modulated service above 207 kPa (30 psig).

3.5.3 Provide Balanced Pressure Thermostatic steam traps at steam risers.

3.5.4 Size steam traps per following:

3.5.4.1 Constant Pressure: 3 to 1 safety factor.

3.5.4.2 Modulating, 0 – 103 kPa (15 psig): 2 to 1 at 3.4 kPa (½ psi) differential.

3.5.4.3 Modulating, 110 – 207 kPa (16 – 30 psig): 2 to 1 at 13.8 kPa (2 psi) differential.

3.5.4.4 Modulating, 214 kPa (31 psig) and above: 2 to 1 at ½ operating differential.

3.5.5 Provide drip trap assembly at low points and where shown on Drawings.

3.6 STEAM TRAP MONITORING

3.6.1 To be installed on all steam traps including humidifier traps.

3.6.2 Not meant for use on flooded systems.

3.7 FLASH TANK

3.7.1 Provide for high pressure drip traps as shown on Drawings.

3.8 CONDENSATE COOLERS

3.8.1 Install at discharge of traps from humidification systems and pipe to nearest drain or as shown on Drawings.

3.9 MECHANICAL PUMPS

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- 3.9.1 Pump package to be installed below trap at discharge of heat exchanger to insure gravity drainage.
- 3.10 VENTING
- 3.10.1 Pipe all drip pan elbow drains to nearest funnel floor drain.
- 3.10.2 Reductions of vent line size from the outlet of safety relief valves or equipment, or at any point in the vent line will not be acceptable.
- 3.11 STARTUP AND TESTING
- 3.11.1 Have the manufacturer of the equipment examine the installed components for proper installation and operation at time of startup.
- 3.11.2 Give 72 hours written notice of date for tests.
- 3.11.3 Insulate or conceal work only after testing and approval by the Consultant.
- 3.11.4 Conduct tests in presence of the Owner.
- 3.11.5 Bear costs including re-testing and making good.
- 3.11.6 Hydraulically test steam-piping system at 1-½ times the system operating pressure or minimum 1,035 kPa (150 psi), whichever is greater.
- 3.11.7 Prior to tests, isolate all equipment or other parts, which are not designed to withstand test pressures or test medium.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All rigid supply, return and exhaust air ductwork and plenums.

1.2.1.2 All flexible ductwork.

1.2.1.3 Emergency generator ventilation system.

1.2.1.4 Balancing dampers.

1.2.1.5 Fire dampers.

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1.2.1.9 Combination fire/smoke dampers.

1.2.1.10 Backdraft dampers.

1.2.1.11 Wall boxes.

1.2.2 Control and smoke dampers, airflow measuring stations shall be supplied under the work of Division 25 – Integrated Automation and installed as per of the work of this Section.

1.3 SUBMITTALS

1.3.1 Submit shop drawings for all products supplied in this Section.

1.4 DEFINITIONS

1.4.1 References to SMACNA shall mean “HVAC Duct Construction Standards, Metal and Flexible”, current edition.

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2 **PRODUCTS**

2.1 DUCTWORK

- 2.1.1 Fabricate the following ductwork from galvanized steel, in accordance with requirements of SMACNA 1000 Pa (4" w.g.) pressure class:
 - 2.1.1.1 All supply air ductwork from air handling units to air terminal control units.
 - 2.1.1.2 All ventilation air supply ductwork.
 - 2.1.1.3 All ductwork used for smoke exhaust, including relief air ductwork.
- 2.1.2 Fabricate the following ductwork from aluminum in accordance with requirements of SMACNA 500 Pa (2" w.g.) pressure class:
 - 2.1.2.1 Shower exhaust.
- 2.1.3 Fabricate the following ductwork from galvanized steel, in accordance with requirements of SMACNA 500 Pa (2" w.g.) pressure class:
 - 2.1.3.1 All remaining rigid rectangular ductwork and plenums.
- 2.1.4 Galvanized steel shall be Class G90 have a coating thickness of 275 g/m² (0.9 oz./sq.ft) total both sides galvanizing coat to ASTM A653 standards.
- 2.1.5 Aluminum shall be utility grade with not more than 0.40% copper minimum tensile strength of 110.3 MPa (16,000 psi) and suitable for Pittsburgh lock seam construction. Refer to SMACNA manual for conversion of galvanized duct thickness to acceptable aluminum duct thickness.
- 2.1.6 Construct round ductwork to meet the requirements of SMACNA 1500 Pa (6" w.g.) pressure class and as follows:
 - 2.1.6.1 Provide welded slip joint construction round duct fittings. Wipe pipe and fittings with Durodyne S-2 duct sealer before assembly. Secure joints with self-tapping screws, and then brush again with thick coat of duct sealer.
 - 2.1.6.2 Provide die-formed round elbows through to 200mm (8") diameter constructed by 1.0mm (20-gauge) galvanized steel. Provide five-section construction for larger elbows.

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- 2.1.6.3 Provide conical round tees.
- 2.1.7 Construct flat oval ductwork using galvanized steel construction as follows:
 - 2.1.7.1 Factory fabricated by United Sheet Metal, spiral uniseal through 500mm (20") minor axis, 0.7mm (24-gauge) for up to 600mm (24") major axis.
 - 2.1.7.2 Fittings shall be continuous weld, 1.0mm (20-gauge) up to 900mm (36") major axis.
 - 2.1.7.3 Elbows shall be easy bend.
 - 2.1.7.4 Transitions shall have OTR-10 reinforcement.
- 2.2 **BALANCING DAMPERS**
 - 2.2.1 Construct all dampers of the same type of material used for the ductwork.
 - 2.2.2 For dampers in rectangular ductwork:
 - 2.2.2.1 Construct volume dampers not greater than 225mm (9") in height of minimum 1.6mm (16-gauge) steel, centrally hinged. Use a Durodyne type KS-385 linkage.
 - 2.2.2.2 Construct volume dampers with a height greater than 225mm (9") of not less than 1.6mm (16-gauge) steel with reinforced leaves, centrally hinged, bronze or nylon bushings, mounted on a 13mm (½") square rod in 2.7mm (12-gauge), 38mm (1-½") channel frame, securely held by a Durodyne KP-22 locking quadrant with indicating device. The dampers shall be of multi-blade, opposed type construction with a maximum blade length not exceeding 1.2m (4 ft) and a maximum blade height of 150mm (6").
 - 2.2.2.3 Allowable leakage when closed against 1kPa (4" w.g.) at 7.62 m/s (1,500 fpm) face velocity 10%. Provide threaded rod and nut (metric thread) lever adjustment with washer and locknut.
 - 2.2.2.4 Place quadrants on insulated cuts on a bracket so that the quadrant lock is outside the insulation at all times. Place quadrants such that the limiting two (2) positions of the damper correspond to the limiting positions of the quadrant.
 - 2.2.3 For dampers in round ductwork, use double thickness, aerodynamically shaped, butterfly dampers with rounded edges, tack

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welded to steel shafts set in nylon bushings complete with glands and asbestos rope packing. Use quadrants as described for low-pressure ductwork louver dampers. Use dampers constructed to function at the indicated pressures, smoothly without undue noise or vibration. Allowable leakage 5% against 1.5kPa (6" w.g.) and at 10.2 m/s (2,000 fpm) face velocity.

2.2.4 Splitter dampers to be constructed of galvanized sheet metal, two (2) gauges heavier than the duct, maximum 1.3mm (18-gauge). Splitter dampers up to 600mm (24") will be securely attached to a single steel pivot rod, which will be set in metal sockets attached to duct. End of the splitter to be turned over to form a teardrop and on this end the rod will be connected. On splitter dampers 625mm (25") and larger, provide two (2) rods. These rods will be provided with setscrew locking devices to hold position. Splitter dampers to be made rigid by reinforcing them. Duct panels surrounding splitter damper will not be cross-broken, but will be reinforced to prevent sagging or drumming. Length of splitter shall be at least 300mm (12") long or 1-1/2 times the width of the smaller branch whichever is longer.

2.2.5 Quadrants on insulated ducts to be placed on a bracket so that quadrant lock is on surface of insulation. Quadrants will be placed so that the limiting two (2) positions of the damper correspond to the limiting positions of the quadrant.

2.3 FIRE DAMPERS

2.3.1 Provide, where shown and required by ordinance or codes, fire dampers made to NFPA Standard 90A and ULC listed and to the approval of all authorities having jurisdiction. Fire damper shall be complete with steel frame, fusible link, steel blades, stainless steel closure springs and blade lock for horizontal curtain type dampers.

2.3.2 Dampers shall be Type 'B' (with pocket) unless space limitations do not permit.

2.3.3 Provide horizontal or vertical fire dampers to suit each application.

2.3.4 Provide dynamic fire dampers for air systems which fan blowers do not shut down during a fire alarm. Provide static fire dampers for air systems which fan blowers shut down during a fire alarm.

2.4 SMOKE DAMPERS

2.4.1 Smoke dampers to be Ruskin SD35 Class III (or equal), dampers

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to maintain smoke-rating integrity of membrane being pierced.

2.4.2 Assembly to have the following construction:

2.4.2.1 Frame: 127 x minimum 1.6 mm (5 inches x minimum 16 gage) roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 2.3 mm (13 gage) U-channel type frame.

2.4.2.2 Blades: Opposed, single skin with 3 longitudinal grooves, minimum 1.6 mm (16 gage) galvanized steel, width maximum 152 mm (6 inches). Flat blades are not acceptable.

2.4.2.3 Bearings: Self-lubricating stainless steel sleeve type, turning in extruded hole in frame.

2.4.2.4 Jamb seal: Stainless steel, flexible metal compression type. Glue-on seals are not acceptable.

2.4.2.5 Linkage: Concealed in frame.

2.4.2.6 Axles: Minimum 13mm (½ inch) diameter plated steel, hex-shaped, mechanically attached to blade.

2.4.2.7 Mounting: Vertical or Horizontal.

2.4.2.7.1 Close (in a controlled manner) and lock damper during test, smoke detection, power failure, or fire conditions through actuator closure spring. At no time shall actuator disengage from damper blades.

2.4.2.7.2 Allow damper to be automatically and remotely reset after test or power failure conditions. After exposure to high temperature or fire, inspect damper before reset to ensure proper operation.

2.4.2.7.3 Controlled closing and locking of damper in 7 to 15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable.

2.4.2.8 Actuator: Electric 120 V, 60 Hz, two-position, fail close, externally mounted.

2.4.2.9 Finish: Mill galvanized.

2.4.2.10 One piece mounting angle with pre-punched screw holes.

2.4.2.11 Factory sleeve: Minimum 1.0mm (20 gage) thickness, minimum 432mm (17 inches long). Silicone caulk factory applied to sleeve at

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damper frame to comply with leakage rating requirements.

2.4.2.12 Break-away connections

2.4.3 Optional accessories:

2.4.3.1 Two position indicator switches linked directly to damper blade to remotely indicate damper blade position.

2.4.3.2 Phototelectronic type/Ionization type duct smoke detector, factory mount.

2.4.4 Provide multiple dampers where sizes exceed code limitations.

2.4.5 Select dampers with airflow resistance not exceeding 13 Pa (0.05" w.g.) at design flow rates.

2.5 FLEXIBLE CONNECTIONS

2.5.1 Connect fan units to ductwork by means of 150mm (6") wide heavy 'Ventglas' fabric securely fastened to equipment and ductwork by a galvanized steel band, provided with tightening screws. Ensure that all connections are leakproof. Provide 1.3mm (18-gauge) protective collar over flexible connections.

2.6 FLEXIBLE DUCTWORK

2.6.1 Connections to diffusers will be by means of Flexmaster T/L triple-lock aluminum flexible ducting made of dead soft aluminum, and manufactured in a manner to produce a triple-lock mechanical seam forming a continuous and secure air tight joint.

2.7 ACOUSTIC DUCT LINING

2.7.1 Where indicated on drawings, line ductwork inside with fibreglass acoustic duct insulation. Insulation to comply with ULC S110-M.

2.7.2 Facing for low velocity duct liner (max. 12.2 m/s - 2,400 fpm) shall be a tightly bonded mat, stenciled as per NFPA 90.

2.7.3 Facing for circular ducts and medium/high velocity ductwork (over 12.2 m/s - 2,400 fpm), or where indicated on drawings shall be with perforated, minimum 28 percent open area, minimum 0.85mm (22-gauge) thick galvanized steel finish.

2.7.4 Provide lining with minimum thickness and density as follows:

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- 2.7.4.1 In ductwork 25 mm (1") at 24 kg/m³ (1-½ lb/ft³), unless otherwise noted on drawings.
- 2.7.4.2 In plenums 50 mm (2") at 32 kg/m³ (2 lb/ft³).
- 2.7.4.3 In linear slot diffuser plenums 13 mm (½") at 24 kg/m³ (1-½ lb/ft³).
- 2.7.5 Lining media shall have a flamespread classification of not greater than 25, when tested in accordance with ASTM E84, NFPA Standard 255, CAN 4-S102, or UL No. 723. Furthermore, fuel contribution and smoke development rating shall not be greater than 50, when tested in accordance with ASTM E84, NFPA Standard 255, CAN 4-S102, or UL No. 723.
- 2.7.6 Lining shall be suitable for duct velocity of 30.5 m/s (6,000 fpm), without erosion damage.
- 2.7.7 Media shall have the following physical properties:
 - 2.7.7.1 Maximum thermal conductivity of 1.42 W/m² °C (0.24 BTU/ft² hr °F), at 25mm (1") thickness and 24 kg/m³ (1-½ lb/ft³) density.
 - 2.7.7.2 Sound absorption coefficient (NRC) of minimum 0.7, at 25mm (1") thickness and 24 kg/m³ (1-½ lb/ft³) density (ASTM C423).
- 2.8 **BACKDRAFT DAMPERS**
 - 2.8.1 Backdraft dampers shall have galvanized steel channel frames, full blade-length shafts, brass, ball or nylon bearings, neoprene blade strips secured to pivot side of blades, counter balance weights and suitable for vertical or horizontal mounting.
 - 2.8.2 Maximum blade length shall be 750mm (30"). Use multiple units for larger sizes.
 - 2.8.3 Maximum resistance to air flow shall be 50 Pa (0.2" w.g.) at design airflow. Increase damper size to meet pressure drop requirement.
- 2.9 **COMBINATION FIRE AND SMOKE DAMPERS**
 - 2.9.1 Combination fire/smoke dampers to be Ruskin FSD35 Class III dampers to maintain fire-rating integrity of membrane being pierced. Minimum fire rating shall be 1-½ hours in accordance with UL555.
 - 2.9.2 Assembly to have the following construction:

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- 2.9.2.1 Frame: 127 x minimum 1.6 mm (5 inches x minimum 16 gage) roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 2.3 mm (13 gage) U-channel type frame.
- 2.9.2.2 Blades: Opposed, single skin with 3 longitudinal grooves, minimum 1.6 mm (16 gage) galvanized steel, width maximum 152 mm (6 inches). Flat blades are not acceptable.
- 2.9.2.3 Bearings: Self-lubricating stainless steel sleeve type, turning in extruded hole in frame.
- 2.9.2.4 Jamb seal: Stainless steel, flexible metal compression type. Glue-on seals are not acceptable.
- 2.9.2.5 Linkage: Concealed in frame.
- 2.9.2.6 Axles: Minimum 13mm (½ inch) diameter plated steel, hex-shaped, mechanically attached to blade.
- 2.9.2.7 Mounting: Vertical or Horizontal.
- 2.9.2.8 Temperature release device: Heat-Actuated, Quick Detect
 - 2.9.2.8.1 Close (in a controlled manner) and lock damper during test, smoke detection, power failure, or fire conditions through actuator closure spring. At no time shall actuator disengage from damper blades.
 - 2.9.2.8.2 Allow damper to be automatically and remotely reset after test or power failure conditions. After exposure to high temperature or fire, inspect damper before reset to ensure proper operation.
 - 2.9.2.8.3 Controlled closing and locking of damper in 7 to 15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable.
- 2.9.2.9 Actuator: Electric 120 V, 60 Hz, two-position, fail close, externally mounted.
- 2.9.2.10 Finish: Mill galvanized.
- 2.9.2.11 One piece mounting angle with pre-punched screw holes.
- 2.9.2.12 Factory sleeve: Minimum 1.0mm (20 gage) thickness, minimum 432mm (17 inches long. Silicone caulk factory applied to sleeve at damper frame to comply with leakage rating requirements.

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- 2.9.2.13 Break-away connections
- 2.9.3 Provide multiple dampers where sizes exceed code limitations.
- 2.9.4 Select dampers with airflow resistance not exceeding 13 Pa (0.05" w.g.) at design flow rates.

3 **EXECUTION**

3.1 DUCTWORK

- 3.1.1 All ductwork construction and installation to be in accordance with recommendations of the current SMACNA standards unless otherwise noted in this Section.
- 3.1.2 Sheet metal, which is not to be insulated, will be cross-broken on the four sides of each panel section. All vertical and horizontal sheet metal barriers, duct offsets; elbows, as well as the panels of straight sections of ducts will be cross-broken. Cross-breaking to be applied to the sheet metal between the standing seams or reinforcing angles. The centre of the cross-break will be of the required height to assure surfaces being rigid. Insulated sheet metal and ducts will not be cross-broken.
- 3.1.3 Where it is necessary that ducts be divided, due to pipes, hangers, or other obstructions, which must pass through the ducts, provide teardrop shaped deflectors around these obstructions so that they will not interfere with the movement of air. Ductwork around these deflectors to be increased in size to maintain equivalent free area around deflectors. Holes in ductwork to be caulked and cover-plated to close any space left between edge of hole and obstruction passing through ducts. The passing of pipes or other obstructions through ducts will only be done when authorized at the Site, by the Consultant.
- 3.1.4 In square elbows and in elbows where radius is less than $1\text{-}\frac{1}{2}$ x width of duct, sheet metal deflector vanes will be installed the full height of duct, being securely riveted in place. All vanes to be double thickness vanes of same gauge as duct in which they are installed. Vanes to be tack welded. For vane lengths over 1.2m (4 ft) tack weld vanes to 9mm ($\frac{3}{8}$ ") tie-rod at mid-span.
- 3.1.5 All necessary allowances and provisions will be made in the installation of the ducts for structural framing of the building and when changes or offsets are necessary, the required areas shall be maintained. All of these changes however, must be approved,

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and installed as directed by the Consultant at that time.

- 3.1.6 During installation, the open ends of ducts must be protected with blank, flanged sheet metal baffles, securely attached to prevent debris and dirt from entering.
- 3.1.7 Where ducts are shown connecting to masonry openings and/or along the edges of all plenums at floors, walls, etc., provide a continuous 38mm x 38mm x 4.7mm (1-½" x 1-½" x 3/16") galvanized angle steel, which will be bolted to the structure and made airtight to same by applying caulking compound on the angles before they are drawn down tight. The sheet metal at these locations will be bolted to the angle steel framing.
- 3.1.8 All air ducts, casings, plenums, etc., to be constructed of lock forming quality prime galvanized steel sheets, which are free from blisters, slivers, imperfectly coated spots, etc., no second quality sheet metal allowed.
- 3.1.9 Ducts to be constructed using double or Pittsburgh lock corner seams. All seams to be hammered down and made airtight. For transverse joint refer to current ASHRAE Guide for low-pressure ductwork.
- 3.1.10 Gauges and reinforcing of sheet metal ductwork will be as indicated in the current SMACNA manual, except 0.55mm (26-gauge) ductwork will not be allowed.
- 3.1.11 All sheet metal connections for apparatus plenum chambers, etc., to be constructed on 1.3mm (18-gauge) metal reinforced with 38mm x 38mm x 4.7mm (1-½" x 1-½" x 3/16") galvanized angles up to 2.4m (8 ft) in height. When height exceeds 2.4m (8 ft) angles shall not be less than 50mm x 50mm x 6mm (2" x 2" x ¼"). In all case provide connections structurally designed for maximum fan pressures.
- 3.1.12 Angles on all apparatus and plenum chambers to be installed on not more than 1.2m (4 ft) centres and at all vertical and longitudinal seams on the plenum construction.
- 3.1.13 Ensure that all openings required through floors, walls, partitions, etc., for the duct system are provided in the exact location.
- 3.1.14 The bottom joint and 150mm (6") of vertical joint on outside air intake ducts and mixing chamber ducts will be soldered and made watertight. Provide drain connection and run copper drainpipe to

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nearest floor drain.

- 3.1.15 Provide 50mm (2") insulated sheet metal blank off panels behind unused portions of exterior louvers.
- 3.1.16 Connect flexible ductwork using stainless steel worm drive clamps, adjustable clamps, or duct straps applied over two wraps of duct tape.
- 3.1.17 Maximum length of flexible ducts shall be 3.6m (12 ft). Utilize rigid ductwork as required to meet this requirement.
- 3.1.18 Install flexible ductwork clear of ceiling assemblies, light fixtures, etc. Support by 25mm (1"), 0.85mm (22-gauge) galvanized steel straps at 1.5m (5 ft) centres.
- 3.1.19 Frame and install motorized dampers. Attach each motorized damper module to channel framing.
- 3.1.20 Seal all ductwork in accordance with the appropriate SMACNA "Standard Duct Sealing Requirements". All sealants shall be ULC listed in accordance with standard S-102. Where insulation is applied internally to ductwork, metal duct shall act as vapour barrier and all joints to be completely sealed. Ductwork shall be leak tested at the rated pressure in accordance with SMACNA HVAC Duct Leakage Test Manual. A leak test report shall be provided to the Consultant. Duct sealing and leak testing shall be conducted before ductwork is insulated or concealed by drywall to allow for re-sealing or repairing duct sections.
- 3.1.21 Ductwork modification:
 - 3.1.21.1 Make all necessary allowances and provisions for the structural framing of the building. Do not execute any such changes without permission of the Consultant.
 - 3.1.21.2 Transform or divide low-pressure ducts (up to 500 Pa / 2" w.g. static pressure) as may be required. Maintain the indicated cross sectional areas. Do not exceed an aspect ratio of 4 to 1. Install air stream deflectors when pipes and other small obstructions must pass through ducts, but maintain the free passage area.
 - 3.1.21.3 Transform rectangular ducts for pressures higher than 500 Pa (2" w.g.). Do not exceed the initial pressure drop. Do not exceed an aspect ratio of 4 to 1. Do not pass any obstructions through any of these ducts.

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3.1.21.4 Round or oval ducts for pressures higher than 500 Pa (2" w.g.). Do not change dimensions without obtaining approval. Do not pass any obstructions through any of these ducts.

3.2 BALANCING DAMPERS

3.2.1 Provide balancing dampers in all locations necessary for balancing the air system including but not necessarily limited to the following locations:

3.2.1.1 Where ducts enter or leave duct shafts, (including ducts to last floor where shafts may not exist).

3.2.1.2 In all supply branches without reheat coil stations (e.g. corridors, electrical rooms, etc.).

3.2.1.3 In all other locations shown on the Drawings.

3.2.2 Note: For clarity of Drawings, balancing dampers mentioned under paragraphs 3.2.1.1. and 3.2.1.2. are not shown or indicated on the Drawings, but must be supplied and installed.

3.2.3 In each branch connection, install splitter dampers in supply ducts and louver dampers in return ducts.

3.2.4 Install duct mounted louver type dampers between angle steel duct framing, using neoprene gasket. In stainless steel ducts, cover the neoprene gaskets with Teflon tape.

3.2.5 Bolt all dampers in plenum wall to a counter frame using a neoprene gasket between damper and wall.

3.2.6 Install access doors and panels at all dampers, to provide access to the entire damper assembly.

3.3 FIRE DAMPERS, SMOKE DAMPERS, COMBINATION SMOKE/FIRE DAMPERS

3.3.1 Before proceeding with any work, submit erection drawings approved by all authorities having jurisdiction showing location and construction details of all fire dampers.

3.3.2 Install dampers at locations indicated on the drawings and in accordance with manufacturer's UL approved installation instructions.

3.3.3 Install dampers square and free from racking with blades running

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horizontally.

- 3.3.4 Provide steel retaining angle and steel wall sleeve/collar for proper installation of the damper.
- 3.3.5 Do not compress or stretch damper frame into duct or opening.
- 3.3.6 Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jackshaft.
- 3.3.7 Enlarge duct sections around fire dampers, to allow unrestricted duct area while damper is in open position. Provide approved type access doors with airtight gaskets, for inspection and servicing of fire dampers. Provide dampers in supply and return take-offs at each floor of the multiple louver type.
- 3.3.8 Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.
- 3.3.9 Provide fire dampers in all ducts over 0.013m² (0.14 sq.ft) in area in the location shown on drawings, whether or not specifically requested by ordinances and codes.
- 3.3.10 For stainless steel exhaust ducts provide butterfly fire dampers constructed of stainless steel.
- 3.3.11 Line side power wiring and control wiring connections to fire alarm system for smoke dampers and combination fire/smoke dampers shall be provided by Division 26 - Electrical. Coordinate wiring requirements and exact location of dampers with Division 26 - Electrical Contractor.

3.4 CONTROL DAMPERS

- 3.4.1 Install automatic control dampers in all relief ducts to the outside, in all return ducts to the main air handling units from all main return-relief fans, and elsewhere where shown. Install all damper sections between angle steel frames attached to the ductwork.

3.5 WATERPROOF EXHAUST

- 3.5.1 Provide waterproof ductwork where aluminum ductwork is specified in the Contract Documents. All joints shall be made watertight using caulking. Slope ducts back to source to facilitate drainage. Where this is not feasible, provide intermediate drains piped to nearest floor drain. All joints shall be made watertight.

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3.6 CLEANING OF AIR SYSTEMS

- 3.6.1 Wipe clean all ductwork internally before erection.
- 3.6.2 After completing the systems, vacuum clean all ductwork and all apparatus internally through cleanouts.
- 3.6.3 Run air systems for at least twelve (12) operational hours using throwaway filters in place of permanent filters. Include for additional throwaway filter as well as for filters for all air handling units provided under this Contract.
- 3.6.4 Have all ductwork inspected for internal cleanliness. Obtain the Consultant's permission for the installation of all permanent filters in order to facilitate balancing.

3.7 DUCT ACCESS PANELS AND TEST HOLES

- 3.7.1 Access Panels:
 - 3.7.1.1 Provide all access doors of the same material as used for the ducts in which they are to be installed. Ensure through gasketing and suitable fastening materials that the entire systems are completely free from corrosion, water leakage (washable ducts), and air leakage (all ducts).
 - 3.7.1.2 Ensure that all duct access doors are easily accessible through the structure.
 - 3.7.1.3 All access doors will be in accordance with NFPA Standard 90-A. Construct all duct or apparatus access panels from double thickness frame, 25mm (1") apart, with necessary reinforcing for rigidity. Provide access panels on insulated ducts apparatus with 25mm (1") space filled with fibreglass insulation. Make panels airtight with a continuous rubber gasket. Provide openings in ductwork or casings with continuous galvanized reinforcing bars, extended on insulated ductwork or casings, to the face of the insulation.
 - 3.7.1.4 Provide 450mm x 450mm (18" x 18") and smaller panels with at least two (2) brass window sash fasteners, larger panels with at least two (2) brass pin hinges and two (2) fasteners. Make fasteners on wall-through panels operational from inside and outside. Provide all panels with brass drawer type handles (two (2) minimum, each).

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- 3.7.1.5 Provide access panels where shown, and in the following locations whether shown or not:
 - 3.7.1.5.1 In ductwork to facilitate full cleaning of all ducts.
 - 3.7.1.5.2 Bottom of all duct risers.
 - 3.7.1.5.3 Next to outside air intakes and outlets.
 - 3.7.1.5.4 At fire dampers.
 - 3.7.1.5.5 Into plenums and apparatus casings to facilitate maintenance and cleaning of all components.
 - 3.7.1.5.6 Immediately upstream and downstream of each reheat coil.
- 3.7.1.6 In ducts vulnerable to settlement of liquids or solids, provide reach-through type access doors size 250mm x 200mm (10" x 8") of rigid construction complete with frame and counter frame, bolted and gasketed. Provide insulated doors in ducts that are to be used for access.
- 3.7.1.7 In all other ducts provide access doors of adequate size to allow for inspection, cleaning and for general maintenance, of dampers, filters, louvers, birdscreens, coils, thermostats, thermometers, firestats, fire linkages and all other duct mounted appurtenances. Provide reach-through type access doors of rigid construction with frame and counter-frame, hinged and sash locked with gasket. Insulate doors for ducts that are to be insulated.
- 3.7.2 Test Holes:
 - 3.7.2.1 At each main branch in ductwork and at each fan discharge and suction, provide sufficient number of Pitot tube test holes for balancing systems. Also, provide test holes for traverse at fan discharge.
 - 3.7.2.2 Test holes to be located within easy reach of catwalks or ladders.
 - 3.7.2.3 Each test hole will have 19mm ($\frac{3}{4}$ ") clear opening, provided with a metal ring plate with a threaded hole, and a matching screwed head plug. Where these plugs are installed in insulated ductwork, provide an extension collar against which the insulation can be finished.
 - 3.7.2.4 Reinforced holes to be provided where thermometers, manometers, thermostats, gauges, damper rods, etc., occur in

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ductwork. Extended collars will be provided for the reinforced holes where these occur on insulated ductwork.

- 3.7.2.5 Where copper tubing passes through ductwork, or casing, provide a rubber grommet to prevent damage to copper tubing.

3.8 ACOUSTIC DUCT LINING

- 3.8.1 Secure to ductwork with approved fire retardant adhesive suitable for fibreglass insulation using 100% coverage and 2.7mm (12-gauge) anchors, or minimum 1.9mm (14-gauge) weld pins on 400mm (16") centres. Cut-off excess fastener length after mechanical fasteners (speed clips) have been applied. Transverse joints shall be firmly butted with no gaps and longitudinal corner joints shall be overlapped and compressed. Coat all joints, raw edges, rips, and protrusions with approved mastic. Provide continuous sheet metal edge protectors at entering and leaving edges of lined duct sections, and all joints.

- 3.8.2 Duct dimensions shown are clear inside dimensions. Increase duct dimensions to suit thickness of duct lining.

- 3.8.3 Unless noted otherwise in the Contract Documents, acoustic insulation shall be installed in accordance with SMACNA Standard for Metal and Flexible Duct.

- 3.8.4 Extent of ductwork acoustic lining:

- 3.8.4.1 Downstream of air terminal control units (CAV, VAV and fan powered), except units supplied with integral attenuator, for min. 1,524mm (5 ft) length.

- 3.8.4.2 Downstream of heat pump units, for min. 2,438mm (8 ft) overall length, or min. 914mm (3 ft) length beyond the first 90 degree elbow.

- 3.8.4.3 All toilet exhaust branch ducts which serve different toilet rooms from same riser on the same level unless at least 5m (16 ft) of ductwork, including at least three (3) of 90 degree elbow separate grilles in separate rooms.

- 3.8.4.4 Air transfer ducts for full length.

- 3.8.4.5 Return air stub ducts at shaft intake openings for full length.

- 3.8.4.6 All ductwork serving spaces with noise criteria of NC-30 or lower.

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3.8.4.7 Where indicated on the Drawings.

3.8.5 Where ductwork velocities exceed 12.2 m/s (2,000 fpm), use of internal lining shall be reviewed with the Consultant in fulfilling the above requirements. If internal lining is deemed unsatisfactory for the particular application, provide perforated metal facing over internal lining, or sound traps as directed.

3.9 INSULATED PLENUMS AND CASINGS

3.9.1 Provide insulated metal sandwich panels for all exterior intake and exhaust air plenums consisting of prefabricated 1.3mm (18-gauge) galvanized sheet metal panels and 50mm (2") rigid fibreglass insulation with interlocking joints securely fastened.

3.9.2 Provide steel supports, joiner sections, floor channels, opening frames and sealing materials. Provide 1.3mm (18-gauge) minimum channel stiffeners at not greater than 800mm (32") centres.

3.9.3 Connect corners and butt joints with 1.6mm (16-gauge) galvanized sections. Seal all joints with rubber mastic. Use angle joints to attach panel edges to walls.

3.9.4 Construct entire plenum to resist deflection and seal sufficiently to avoid air leakage when subjected to a pressure differential between inside and outside of up to 2,490 Pa (10" w.g.)

3.9.5 Provide access doors suitable for personnel pass through.

3.9.6 Insulate plenum floors with 25mm (1") rigid fibreglass insulation and cover with 1.6mm (16-gauge) galvanized sheet metal panels.

3.9.7 Seal penetrations through plenum walls with gland seals.

3.9.8 Construct drain pans from 1.6mm (16-gauge) type 304 stainless steel. Weld all joints. Install DN32 (1-¼") DWV drain connection to nearest drain complete with deep seal trap (minimum 100mm / 4"). Install to completely drain the pan.

END OF SECTION

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3.2	Sound Proof Construction for Duct Penetrations

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Complete noise control system to prevent noise levels from exceeding the room criteria listed in Table 1, Chapter 48 of the ASHRAE 2011 HVAC Applications Handbook.

1.2.2 System shall include sound attenuating units (silencers), sound proofing construction, and external sound proofing, provided under this Section, and acoustic duct lining provided under Section 23 30 13 – Ductwork and Accessories.

1.2.3 In addition to the work covered under this Section, coordinate the equipment supplied under the work of other Sections of this Division and of other Divisions, to comply with the requirements contained in this Section.

1.3 SUBMITTALS

1.3.1 The Division 23 – HVAC Subcontractor shall supply to the noise control manufacturer approved drawings of all equipment to be acoustically attenuated, including sound power level data.

1.3.2 The noise control manufacturer shall supply shop drawings of all silencers to be used on the project. The data shall include dynamic insertion loss, generated noise and pressure drop. Data shall be certified by a qualified independent testing laboratory.

1.3.2.1 The insertion loss shall consist of sound pressure level in the diffuse sound field of a reverberant room where a silencer is substituted for the same length of empty duct and the rest of the system unchanged.

1.3.2.2 The test method used by the Independent Testing Laboratory certifying the silencer data shall be fully described.

1.3.2.3 The certification of the pressure drop, insertion loss, and generated

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noise data shall be based upon tests of the same silencer for all measurements.

- 1.3.3 Submit letter from manufacturer certifying silencers have been installed in accordance with their recommendations and the contract documents.

1.4 QUALITY ASSURANCE

- 1.4.1 Noise levels due to equipment and ductwork shall permit attaining sound pressure levels in all eight (8) octave bands in occupied spaces conforming to room criteria listed in Table 1, Chapter 48 of the ASHRAE 2011 HVAC Applications Handbook.
- 1.4.2 Acoustical Performance within Equipment Spaces:
 - 1.4.2.1 Equipment room noise levels and noise transmission to adjacent buildings shall comply with the local statutory requirements.
 - 1.4.3 Motor Acoustical Performance:
 - 1.4.3.1 All motor drives when installed per plans and specifications shall operate with noise levels not exceeding 80 dBA.
 - 1.4.3.2 Noise levels shall be determined in accordance with IEEE Standard #85 Test "Procedure for Airborne Noise Measurements on Rotating Electric Equipment".
 - 1.4.4 Transformer Acoustical Performance:
 - 1.4.4.1 Maximum permissible sound pressure level when operated under installed conditions shall be 80 dBA when measured with an ANSI S1.4-1983 "Type 1" sound level meter at any point which is 1.0m (40") from the equipment housing.
 - 1.4.5 Air Distribution System; Pressure Reducing Device Noise.
 - 1.4.5.1 Maximum permissible sound power levels in octave bands of airborne transmission through the combination of grille, registers, diffusers, terminal units, related pressure reducing devices and fan coil units, when operated in installed condition per Plans and Specifications, shall be no greater than the maximum in the following table for diffuser heights of less than 4m (13 feet) above finished floor level:

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Air Distribution System Equipment/Terminal Device Noise			
Maximum PWL (dB re: 10 ⁻¹² Watt)			
Octave Band	NC-35	NC-40	NC-45
1	62	66	68
2	56	60	63
3	49	54	58
4	46	51	56
5	43	48	53
6	42	47	52
7	41	46	51
8	42	47	52

- 1.4.5.2 The contractor is hereby advised to exercise the following in order to assure satisfactory acoustical performance of the terminal devices:
- 1.4.5.2.1 Provide proper duct connections to the terminal inlets, with at least three (3) duct diameters of straight ductwork, either flexible or sheet metal, before the duct attachment to the terminal.
- 1.4.5.2.2 Ensure proper air balancing.
- 1.4.5.2.3 Avoid excessive dampering near the terminals.
- 1.4.6 Variable Volume (VAV) Box, Fan Powered VAV Box, Fan Coil and Heat Pump Unit Above Ceiling; Radiated Noise:
- 1.4.6.1 Maximum permissible radiated sound power levels in octave bands when operated over occupied spaces in an installed condition, above a ceiling, shall be as per the following table:

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Maximum Radiated Sound Power (dB re: 10 ⁻¹² Watt)			
Octave Band	NC-35	NC-40	NC-45
1	72	76	79
2	70	74	77
3	61	65	68
4	60	64	68
5	57	62	68
6	56	60	65
7	66	70	75
8	65	70	75

2 PRODUCTS

2.1 GENERAL

- 2.1.1 Silencers shall be of the size, configuration, capacity, and acoustic performance as specified in the Silencer Schedule in the Contract Documents. All silencers shall be factory fabricated and supplied by the same manufacturer.
- 2.1.2 Silencer performance including silencers with fibreglass cloth and Mylar encapsulated media must have been substantiated by laboratory testing according to ASTM E477 and so certified when submitted for approval.
- 2.1.3 Silencer inlet and outlet connection dimensions must be equal to the duct sizes shown on the Drawings. Duct transitions at silencers are not permitted unless shown on the Contract Drawings. A sheet metal elbow in combination with a rectangular silencer is not acceptable as an elbow silencer.
- 2.1.4 Completely prefabricate all silencers using incombustible materials. Silencers shall have rounded inlets and tapered diffuser outlets. Equip circular silencers with centre bodies with spun noses and tapered diffuser outlets.

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- 2.1.5 Media shall be incombustible acoustic quality, shot free fibreglass insulation with long, resilient fibres bonded with thermosetting resin. Density shall be required to insure conformance with laboratory test data. Fibreglass shall be packed with a minimum 10% compression during silencer assembly. Media shall be bacteria and fungus resistant, resilient such that it will not crumble or break and conform to irregular surfaces. Media shall not cause or accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for fibreglass.
- 2.1.6 Media shall have a flamespread classification of not greater than 25, when tested in accordance with ASTM E84, NFPA Standard 255, or UL No. 723. Furthermore, fuel contribution and smoke development rating shall not be greater than 50, when tested in accordance with ASTM E84, NFPA Standard 255 or UL No. 723
- 2.1.7 Silencers shall have 50mm (2") slip connections unless specified otherwise in the Contract Documents. Silencers shall be constructed from galvanized sheet metal or steel sheet. If steel sheet is used, silencers shall be painted with anti-rust prime coat. Supply lifting lugs on units with cross sectional dimensions larger than 600mm (24"). Where silencer is mounted in stainless steel ductwork, the silencer shall be all stainless steel construction to match the ductwork gauges used.
- 2.1.8 Where indicated on the Silencer Schedule, media shall be encapsulated in fibreglass cloth or Mylar film to prevent erosion, shedding, and impregnation of the fibreglass media.
- 2.1.9 All perforated metal shall be adequately stiffened to insure flatness and form. All seams and joints should be mastic filled to insure airtight construction.
- 2.1.10 Silencers shall not fail structurally when subjected to a differential air pressure of 1,992 Pa (8" w.g.)
- 2.2 RECTANGULAR/ELBOW SILENCERS
- 2.2.1 Rectangular silencers shall be constructed according to one of the following classes. Silencers over 1200 mm (48") in any one cross sectional dimension shall be constructed in modules not exceeding 1200 mm (48").
- 2.2.2 Class I: Outer shell shall be minimum 0.85mm (22-gauge) and 0.55mm (26-gauge) inner perforated liner of galvanized steel with airtight mastic filled seams and 50 mm (2") slip connections at

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each end.

2.2.3 Class II: Outer shell shall be minimum 1.3mm (18-gauge) and 0.85mm (22-gauge) inner perforated liner of galvanized steel with spot-welded and caulked seams and steel angle flanges at each end.

2.2.4 Class III: The outer casing shall be a minimum of 1.6mm (16-gauge) hot rolled steel with all seams continuously welded, 0.85mm (22-gauge) inner perforated liner of galvanized steel and steel angle flanges at each end.

2.3 CIRCULAR SILENCERS

2.3.1 Circular silencers shall be welded construction with a minimum 1.6mm (16-gauge) sheet metal outer shell and 0.85mm (22-gauge) perforated sheet metal inner shell for diameters over 600mm (24"). For smaller sizes, 1.3mm (18-gauge) and 0.7mm (24-gauge) respectively shall be acceptable.

2.4 CROSSTALK SILENCERS

2.4.1 Crosstalk silencers shall be constructed of 0.85mm (22-gauge) galvanized outer shell and 0.55mm (26-gauge) galvanized perforated metal.

2.5 REACTIVE SILENCERS

2.5.1 No-media silencers shall contain no absorptive material. Attenuation shall be accomplished by virtue of controlled impedance membranes and broadly tuned resonators.

2.6 HTL CASINGS

2.6.1 Where indicated on the Silencer Schedule, silencers shall have breakout/in protection (HTL - Type I, II, III) externally applied and completely sealed to the silencer casing by the silencer manufacturer to assure quality controlled transmission loss. The HTL walls shall consist of media, airspace, mass and outer protective metal skin, as required, to obtain the specified room NC level. Standard acoustical panels will not be accepted as HTL Walls.

2.6.2 Such HTL walls will extend from within the mechanical equipment room to a point at which flanking through the silencer casing is not a problem.

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2.6.3 Mechanical attachment of the HTL walls to the silencer casing is only permitted at the mechanical room end of the silencer and the termination point of the HTL Wall treatment.

2.7 ACOUSTIC PERFORMANCE

2.7.1 Silencer dynamic insertion loss shall not be less than that listed in the Silencer Schedule. Select silencers to provide the performance stipulated by paragraph 1.2.1.1.

2.7.2 Silencer generated noise shall not be greater than that listed in the Silencer Schedule.

2.7.3 Acoustic performance shall include dynamic insertion loss and generated noise for forward flow (air and noise in same direction) or reverse flow (air and noise in opposite direction) in accordance with project's air distribution system requirements.

2.7.4 All silencer ratings shall be determined in a duct-to-reverberant room test facility, which provides for airflow in both directions through the test silencer in accordance with the ASTM E477-99 test standard. The test set-up, procedure, and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves, and reverberation room absorption.

2.8 AERODYNAMIC PERFORMANCE

2.8.1 Silencer pressure drops shall not exceed those listed in the Silencer Schedule. Silencer pressure drop measurements shall be made in accordance with the ASTM E477-99 test standard. Tests shall be conducted and reported on the identical units for which acoustical data is presented.

3 **EXECUTION**

3.1 GENERAL

3.1.1 Protect all acoustic media from dirt and moisture during construction.

3.1.2 Have the manufacturer inspect the complete installation after system start-up and submit a letter to the Consultant stating that the complete vibration isolation and noise control installation is installed in accordance with its Drawings and instructions and operates to its satisfaction.

3.1.3 After the system has been air balanced, the noise control

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manufacturer shall visit the job and check the sound levels in those areas requested by the Consultant. Conduct sound tests as requested by the Consultant. Determine the necessary corrective measures if applicable, and submit a written report.

3.1.4 Sound measurements shall be in accordance with the "American Standard Method for the Physical Measurement of Sound S1.2".

3.1.5 Sound measuring equipment shall be in accordance with ANSI Standards S1.4 or S1.11.

3.1.6 Maximum static pressure loss:

3.1.6.1 After installation measure total system pressure before and after attenuators.

3.1.6.2 If pressure loss exceeds maximum static pressure loss shown in Schedules, at no charge, replace attenuators and/or modify entrance and/or discharge aerodynamic flow to obtain specified performance.

3.2 SOUND PROOF CONSTRUCTION FOR DUCT PENETRATIONS

3.2.1 Required for openings between ductwork and following construction:

3.2.1.1 Equipment room walls.

3.2.1.2 Floors, except in shafts.

3.2.2 Sound proofing

3.2.2.1 Fill openings with fibrous glass blanket or board for full depth of penetration.

3.2.3 Caulk each side of opening with non-hardening, non-aging caulking compound similar to Johns Manville "Duxeal".

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All fans, not part of equipment assemblies.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for all fans. Shop drawings shall include sound power levels for inlet and outlet at rated capacity, and fan curves.

1.3.2 As a minimum, provide the following information:

1.3.2.1 Product data sheets indicating rated capacities, sound power levels for inlet and outlet at rated capacity, and fan curves for 75%, 100% and 125% of rated RPM.

1.3.2.2 Physical outline dimension drawing showing required clearances, weights, and location and size of connection entries.

1.3.3 Provide manufacturer's certification letter. Refer to Section 20 00 00 – General Requirements.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Provide all fans indicated on the Drawings.

2.1.2 Provide all fan ratings based upon tests performed in accordance with code adopted jointly by the ASHRAE and AMCA. Provide each fan with the AMCA seal. Provide fans with a high efficiency and a pressure characteristic that is constantly rising from free delivery to shut-off. Fans to have non-overloading horsepower characteristics.

2.1.3 The fan manufacturer shall provide certified performance curves of

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capacity vs. static pressure; BHP vs. capacity and noise sound power; values at rated RPM and at 75% and 125% of rated RPM. When installed, the fan not performing to the curve will be tested by the fan manufacturer and be 'made good' at no cost to the Owner.

- 2.1.4 Provide all fan wheels statically and dynamically balanced in the manufacturer's plant in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans. Fans to operate quietly and without pulsations.
- 2.1.5 The fan manufacturer shall check that the motor horsepower specified in the Contract Documents is sufficient to accelerate the fan to operating speed without motor overload within normal time limits. If it is found insufficient, the Consultant shall be notified, prior to tendering, and a larger motor and starter will be provided to prevent overloading. If, when installed, motor overload and stopping occur due to fan inertia, the fan manufacturer shall pay all costs incurred for changing motors, starters, wiring, etc.
- 2.1.6 Fans used for smoke exhaust shall be suitable for continuous operation at 205°C (400°F).
- 2.1.7 Fan belts shall be oil and heat resistant, non-static type. Drives shall be precision-machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower.
- 2.1.8 For belt driven fans with variable pitch motor drive, the drive must be factory set to the specified fan RPM.
- 2.1.9 For belt driven fans with fixed drives, allow for one (1) drive change for air balancing purposes (parts only, labour by the Subcontractor responsible for the Air Balancing work under Section 20 05 93).
- 2.2 ALUMINUM PROPELLER FANS – SPD SERIES
- 2.2.1 Fan shall be a wall mounted, direct driven aluminum propeller exhaust fan with integral housing.
- 2.2.2 The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The motor shall be mounted on a 2.1mm (12-gauge) steel wire guard. The wire guard shall be bolted to a minimum 1.9mm (14-gauge) wall panel with continuously welded corners and an integral venturi. Fan shall be enclosed in minimum

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1.3mm (18-gauge) galvanized steel wall housing with factory installed shutter and inlet guard. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design airflow and static pressure. Unit shall be shipped in ISTA certified transit-tested packaging.

- 2.2.3 All non-galvanized steel fan components shall be with an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2 mil thick baked powder finish. Paint must exceed 1,000 hours salt spray under ASTM B117 test method.
- 2.2.4 Propeller shall have aluminum blades riveted to a painted steel hub. The hub shall be securely fastened to the motor shaft utilizing two setscrews.
- 2.2.5 Motor shall be 115/1/60, open drip proof type with permanently lubricated sealed bearings.
- 2.2.6 Supply the following accessories unless described otherwise in the plans and schedules:
 - 2.2.6.1 UL safety disconnect switch
 - 2.2.6.2 Wiring between motor and disconnect switch
 - 2.2.6.3 Gravity shutter
 - 2.2.6.4 Inlet Guard

2.3 ALUMINUM PROPELLER FANS – EWB SERIES

- 2.3.1 Fan shall be a wall mounted, belt driven, propeller exhaust fan.
- 2.3.2 Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The motor, bearings, and drives shall be mounted on a 1.9mm (14-gauge) steel power assembly. The power assembly shall be bolted to a minimum 1.9mm (14-gauge) steel wall panel with continuously welded corners and an integral venturi. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design airflow, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit-tested packaging.
- 2.3.3 All steel fan components shall be with an electrostatically applied, baked polyester powder coating. Each component shall be subject

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to a five stage environmentally friendly wash system, followed by a minimum 2 mil thick baked powder finish. Paint must exceed 1,000 hours salt spray under ASTM B117 test method.

- 2.3.4 Propeller shall be extruded aluminum airfoil design with cast aluminum hub. The blade pitch shall be factory set and locked using setscrews and roll pin. The hub shall be keyed and locked to the shaft utilizing two setscrews or a taper lock bushing.
- 2.3.5 Motor shall be heavy-duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase, and enclosure.
- 2.3.6 Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum catalogued operating speed.
- 2.3.7 Supply the following accessories unless described otherwise in the plans and schedules:
 - 2.3.7.1 UL safety disconnect switch
 - 2.3.7.2 Wiring between motor and disconnect switch
 - 2.3.7.3 Gravity shutter
 - 2.3.7.4 Inlet Guard

2.4 STEEL PROPELLER FANS – XMWH SERIES

- 2.4.1 Fan shall be a wall mounted, belt driven steel propeller exhaust fan.
- 2.4.2 The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The motor, bearings, and drives shall be mounted on a 1.9mm (14-gauge) steel power assembly. The power assembly shall be bolted to a minimum 1.9mm (14-gauge) wall panel with continuously welded corners and an integral venturi. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit-tested packaging.
- 2.4.3 All steel fan components shall be with an electrostatically applied, baked polyester powder coating. Each component shall be subject

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to a five stage environmentally friendly wash system, followed by a minimum 2 mil thick baked powder finish. Paint must exceed 1,000 hours salt spray under ASTM B117 test method.

- 2.4.4 Propeller shall be a high-efficiency fabricated steel design with blades securely fastened to a minimum 4.5mm (7-gauge) hub. The hub shall be keyed and locked to the fan shaft utilizing two setscrews.
- 2.4.5 Motor shall be heavy-duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase, and enclosure.
- 2.4.6 Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum catalogued operating speed.
- 2.4.7 Supply the following accessories unless described otherwise in the plans and schedules:
 - 2.4.7.1 UL safety disconnect switch
 - 2.4.7.2 Wiring between motor and disconnect switch
 - 2.4.7.3 Gravity shutter
 - 2.4.7.4 Wall collar
 - 2.4.7.5 Inlet guard

2.5 CENTRIFUGAL INLINE FANS – SQI/SQN SERIES

- 2.5.1 Fan shall be duct mounted, belt driven centrifugal square inline (HP – high pressure).
- 2.5.2 (SQI-B, SQI-HP) The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. Housing shall be minimum 1.3mm (18-gauge) steel with airflow straightening vanes and integral duct flanges. Adjustable motor plate shall utilize threaded studs for positive belt tensioning. Access door and mounting feet shall be located in the specified position.
- 2.5.3 (SQN-B, SQN-HP) The fan shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 1.3mm (18-gauge) galvanized steel with integral duct collars. Bolted

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access doors shall be provided on three sides, sealed with closed cell neoprene gasketing. Pivoting motor plate shall utilize threaded L-bolt design for positive belt tensioning. Housing shall be pre-drilled to accommodate universal mounting feet for vertical or horizontal installation.

- 2.5.4 Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design airflow, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit tested packaging.
- 2.5.5 (SQI-B, SQI-HP only) All steel fan components shall have an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2-mil thick baked powder finish. Paint must exceed 1,000-hour salt spray under ASTM B117 test method.
- 2.5.6 Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision-machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency.
- 2.5.7 Motor shall be heavy-duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase, and enclosure.
- 2.5.8 Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball type in a cast iron housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
- 2.5.9 Supply the following accessories unless described otherwise in the plans and schedules:
 - 2.5.9.1 UL safety disconnect switch
 - 2.5.9.2 Wiring between motor and disconnect switch
 - 2.5.9.3 Spring vibration isolator set
 - 2.5.9.4 Flexible duct connectors (intake and discharge side)
- 2.6 DUCT/CEILING INLINE FANS – GN/GC SERIES
- 2.6.1 Fan shall be inline (GN) or ceiling (GC) mounted, direct driven,

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centrifugal exhaust fan.

- 2.6.2 The fan wheel housing and integral outlet duct shall be injection molded from a specially engineered resin exceeding UL requirements for smoke and heat generation. The outlet duct shall have provision for an aluminum backdraft damper with continuous aluminum hinge rod. The inlet box shall be minimum 0.85mm (22-gauge) galvanized steel. Motor shall be isolation mounted to a one piece galvanized stamped steel integral motor mount/inlet. A field wiring compartment with disconnect receptacle shall be standard. Unit shall be shipped in ISTA Certified Transit Tested Packaging.
- 2.6.3 (GN) To accommodate different mounting positions, an adjustable prepunched mounting bracket shall be provided.
- 2.6.4 (GC) To accommodate different ceiling thickness, an adjustable prepunched mounting bracket shall be provided. A white, high impact styrene injection molded grill shall be provided as standard. Unit shall be designed with provision for field conversion from ceiling to in-line.
- 2.6.5 Wheel shall be centrifugal forward curved type, injection molded of polypropylene resin.
- 2.6.6 Motor shall be open drip proof type with permanently lubricated bearings and include impedance or thermal overload protection and disconnect plug. Motor shall be furnished at the specified voltage.
- 2.6.7 The following accessories shall be provided by the manufacturer:
 - 2.6.7.1 Fan mount speed controller
 - 2.6.7.2 Wiring between motor and speed controller.
 - 2.6.7.3 Reinforced aluminum backdraft damper with continuous hinge rod.
- 2.7 **MIXED FLOW INLINE BLOWERS – QMX SERIES**
 - 2.7.1 Fan shall be a belt driven, tubular mixed-flow inline blower.
 - 2.7.2 The fan shall be of welded and bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 1.9mm (14-gauge) steel with an electrostatically applied, baked polyester powder coating, with integral inlet and outlet collars for slip fit duct connections. Straightening vanes shall be included to assure maximum efficiency and low noise levels. Adjustable motor plate

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shall utilize threaded studs for positive belt tensioning. Copper extended lube lines shall be furnished for lubrication of fan bearings. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design airflow, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit tested packaging.

- 2.7.3 All steel fan components shall have an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2-mil thick baked powder finish. Paint must exceed 1,000-hour salt spray under ASTM B117 test method.
- 2.7.4 Wheel shall be aluminum, non-overloading, high efficiency mixed-flow type. Blades shall be continuously welded to the back plate and inlet shroud. Hubs shall be keyed and securely attached to the fan shaft. Wheel shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency.
- 2.7.5 Motor shall be heavy-duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase, and enclosure.
- 2.7.6 Blower shaft shall be AISI C-1045 hot rolled and accurately turned, ground and polished. Shafting shall be sized for a critical speed of at least 125% of maximum RPM.
- 2.7.7 Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball or roller type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum catalogued operating speed.
- 2.7.8 Supply the following accessories unless described otherwise in the plans and schedules:
 - 2.7.8.1 UL safety disconnect switch
 - 2.7.8.2 Wiring between motor and disconnect switch
 - 2.7.8.3 Spring vibration isolator set
 - 2.7.8.4 Flexible duct connectors (intake and discharge side)

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2.8 TUBULAR CENTRIFUGAL INLINE FANS – CVB SERIES

- 2.8.1 Fan shall be a spun aluminum, duct mounted, belt driven, tubular centrifugal inline fan.
- 2.8.2 The fan shall be bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum housing shall be constructed of minimum 3.0mm (11-gauge) marine alloy aluminum with inlet and outlet flanges. Straightening vanes shall be utilized for uniform airflow. Extended lube lines shall be furnished for lubrication of fan bearings. Aluminum adjustable motor mounting plate shall utilize threaded studs for positive belt tensioning. The adjustable mounting brackets shall be constructed of minimum 3.8mm (8-gauge) aluminum with extruded rubber isolation between bracket and fan housing. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design airflow, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit tested packaging.
- 2.8.3 Wheel shall be a non-overloading design utilizing airfoil blades for maximum efficiency. The aluminum airfoil blades shall be welded to a spun aluminum dome. The dome shall be bolted to an aluminum hub assembly. The hub shall be keyed and locked to the fan shaft utilizing two setscrews.
- 2.8.4 Motor shall be heavy-duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase, and enclosure.
- 2.8.5 Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball type in a cast iron housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
- 2.8.6 Supply the following accessories unless described otherwise in the plans and schedules:
- 2.8.6.1 UL safety disconnect switch
- 2.8.6.2 Wiring between motor and disconnect switch
- 2.8.6.3 Spring vibration isolator set
- 2.8.6.4 Flexible duct connectors (intake and discharge side)

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2.9 VANE AXIAL FANS – VAB SERIES

2.9.1 Fan shall be a fixed pitch, belt driven vane axial fan.

2.9.2 Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. Housing shall be minimum 2.7mm (12-gauge) steel with continuously welded seam. Housing shall incorporate continuously welded, inlet and outlet flanges of minimum 32mm x 32mm x 6mm (1-1/4" x 1-1/4" x 1/4") and be pre-punched for mounting. Housing shall include nine (9) continuously welded steel discharge vanes and aerodynamically designed belt tunnel. Copper lube lines shall be extended from the bearings to the outside of the housing. Pivoting motor plate shall utilize threaded L-bolt design for positive belt tensioning. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design airflow, static pressure, and maximum fan RPM.

2.9.3 All steel fan components shall have an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five (5) stage environmentally friendly wash system, followed by a minimum 2-mil thick baked powder finish. Paint must exceed 1,000-hour salt spray under ASTM B117 test method.

2.9.4 Propeller shall be fixed pitch, one piece cast aluminum, 7-blade airfoil design. The propeller shall be attached to the shaft utilizing a taperlock bushing and retaining plate bolted to the shaft.

2.9.5 Motor shall be heavy-duty type furnished at the specified voltage, phase, and enclosure.

2.9.6 Construction shall be heavy duty, self-aligning, regreasable ball or roller type in a cast iron housing. Bearing shall be selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed, horsepower, and static pressure.

2.9.7 Fan shaft shall be AISI C-1045 hot rolled and accurately turned, ground and polished. Shafting shall be sized for a critical speed of at least 125% of maximum RPM.

2.9.8 Supply the following accessories unless described otherwise in the plans and schedules:

2.9.8.1 UL safety disconnect switch

2.9.8.2 Wiring between motor and disconnect switch

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- 2.9.8.3 Spring vibration isolator set
- 2.9.8.4 Flexible duct connectors (intake and discharge side)
- 2.10 DOUBLE WIDTH AIRFOIL CENTRIFUGAL BLOWERS – CA SERIES
 - 2.10.1 Fan shall be a double width, double inlet backward inclined airfoil, belt driven centrifugal blower.
 - 2.10.2 The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The scroll wrapper and scroll side panels shall be minimum 2.7mm (12-gauge) steel. The entire fan housing shall have continuously welded seams for leakproof operation and shall have a minimum 38mm (1-½") outlet discharge flange. Fans with lock seam housing construction will not be acceptable. A performance cut-off shall be furnished to prevent the recirculation of air in the fan housing. Bearing support shall be minimum 6mm (1/4") steel. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design airflow, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit-tested packaging.
 - 2.10.3 Steel fan components shall be with an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2 mil thick baked powder finish. Paint must exceed 1,000 hours salt spray under ASTM B117 test method.
 - 2.10.4 Wheel shall be steel, non-overloading, centrifugal backward inclined, airfoil type. Blades on all sizes shall be continuously welded to the backplate and deep spun inlet shroud. Hubs shall be keyed and securely attached to the fan shaft. Wheel shall overlap aerodynamic aluminum inlet cones to provide maximum performance and efficiency.
 - 2.10.5 Motor shall be heavy-duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase, and enclosure.
 - 2.10.6 Blower shaft shall be AISI C-1045 hot rolled and accurately turned, ground and polished. Shafting shall be sized for a critical speed of at least 125% of maximum RPM.
 - 2.10.7 Bearings shall be designed and tested specifically for use in air

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handling applications. Construction shall be heavy-duty regreasable ball or roller type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum catalogued operating speed.

2.10.8 Supply the following accessories unless described otherwise in the plans and schedules:

2.10.8.1 Spring vibration isolators.

2.10.8.2 Lifting lugs.

2.10.8.3 Outlet flange.

2.11 ROOFTOP EXHAUST FANS – ACRU SERIES

2.11.1 Fan shall be a spun aluminum, roof mounted, belt driven, upblast centrifugal exhaust ventilator.

2.11.2 The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 1.3mm (16-gauge) marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one-piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The windband shall have a rolled bead for added strength. A two-piece top cap shall have stainless steel quick release latches to provide access into the motor compartment without the use of tools. An integral conduit chase shall be provided into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 1.9mm (14-gauge) steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design airflow, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit-tested packaging.

2.11.3 Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision-machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency.

2.11.4 Motor shall be heavy-duty type with permanently lubricated sealed

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ball bearings and furnished at the specified voltage, phase, and enclosure.

2.11.5 Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum catalogued operating speed.

2.11.6 Supply the following accessories unless described otherwise in the plans and schedules:

2.11.6.1 UL safety disconnect switch

2.11.6.2 Wiring between motor and disconnect switch

2.11.6.3 Insulated prefabricated curb

2.11.6.4 Gravity backdraft damper unless fan is equipped with automatic damper

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Install fans as shown, with resilient mountings and fan restraining snubbers as specified with vibration isolation and flexible electrical leads.

3.1.2 Install fans with flexible connections on inlet ductwork and on discharge ductwork in accordance with Section 23 30 13 – Ductwork and Accessories.

3.1.3 Provide and install guards on inlets and/or discharge for all fans which are not duct connected.

3.1.4 Align shafts, belt drive, and motor, adjust belt tension, and check motor rotation before start-up.

3.1.5 Protect motors and fans during construction and rotate fans, by hand, every month between delivery and acceptance of building.

3.1.6 Provide torque restrains consisting of spring hangers mounted at 45° angle, for axial fans with 3.73 kW (5 HP) or larger motor and/or 623 Pa (2.5") ESP, installed with flexible connectors.

3.1.7 Adjust variable pitch fan/motor sheaves during balancing to

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achieve specified air quantities.

- 3.1.8 Provide sheaves and belts for final air balance where specified in the Contract Documents.

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Diffusers, Registers and Grilles**
Section No.: **23 37 13**
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3 EXECUTION

- 3.1 Air Outlets (Diffusers, Grilles and Registers)

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Diffusers, Registers and Grilles**
Section No.: **23 37 13**
Date: November 8, 2024

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All supply, return, and exhaust air grilles and diffusers, including all specified ancillaries.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for all registers, grilles, and diffusers.

1.3.2 Shop drawings to indicate dimensions, construction details, finishes and materials, accessories, performance data including throw, pressure drop and sound performance at the specified air flow rates.

1.3.3 Review requirements of outlets as to size, finish, and type of mounting with the Consultant prior to submitting shop drawings and schedules of outlets.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Air outlet application to be based on required maximum space noise levels. Refer to Section 23 33 19 – Duct Silencers.

2.1.2 Provide baffles to direct air away from walls, columns or other obstructions within the radius of diffuser operation.

2.1.3 Provide plaster frame for diffusers located in plaster and gypsum board surfaces.

2.1.4 Provide anti-smudge frames or plaques on diffusers located in rough textured surfaces such as acoustical plaster.

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2.2 REGISTERS, GRILLES AND DIFFUSERS

2.2.1 Refer to the Diffuser and Grille Schedule on Drawings.

3 **EXECUTION**

3.1 AIR OUTLETS (DIFFUSERS, GRILLES AND REGISTERS)

3.1.1 Paint the inside of all duct openings with black flat paint before installing diffusers or registers to it.

3.1.2 Provide sponge rubber gasket around all register frames to ensure an airtight seal against finished wall or ceiling.

3.1.3 Registers and diffusers will be installed in such a manner as to facilitate repeated removals without damaging ceiling or wall construction and finish.

3.1.4 Positions indicated are approximate only. Check location of outlets with the Consultant and make necessary adjustments in position to conform to architectural features, sprinklers, symmetry and lighting arrangement.

3.1.5 Provide diffusers, grilles, and registers as shown on schedule.

3.1.6 On round duct work the angle of duct mounted grilles shall be confirmed with Engineer prior to the start of installation.

END OF SECTION

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Project No.: 2024-0112
Section Name: **Air Filters**
Section No.: **23 41 00**
Date: November 8, 2024

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Duct mount filters.

1.2.1.2 Bag and flat filters in air handling equipment.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for:

1.3.1.1 All air filters.

1.3.2 As a minimum provide the following information:

1.3.2.1 Product data sheets indicating media type, average filter efficiency, pressure drop at clean and dirty condition.

1.3.2.2 Physical outline dimension drawing showing frame dimensions, required clearances, and weights.

1.4 REGULATIONS

1.4.1 Air filters shall conform to requirements of Class 1 filters in accordance with CAN4-S111.

2 **PRODUCTS**

2.1 AIR FILTERS

2.1.1 Provide filters shown on the Filter Schedule and on the Equipment Schedules on the Drawings. They shall be as manufactured by American Air Filter of Canada Ltd or approved equivalent.

2.1.2 Throw Away Filters shall be Renu-Kleen consisting of 1.3mm (18-gauge) galvanized steel wire grids with rear grid fixed and front grid hinged and equipped with latch mechanism. Filter pad shall

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be fibreglass filter media with graduated density, held in place with a thermoplastic bond with each fibre coated with dust holding 'Visosin'.

- 2.1.3 Bag type Filters shall be high efficiency Dri-Pak. They shall consist of a permanent 1.6mm (16-gauge) galvanized steel holding frame with latches and replaceable cartridge.
- 2.1.4 Each cartridge shall contain not less than 2.2 sq.m (23.7 sq. ft) of medium area per 0.093 sq.m (1 sq. ft) of face area.
- 2.1.5 Frames shall permit servicing from clean air side, when no automatic roll pre-filter is provided, or from rear when preceded by automatic roll filter. When no automatic roll prefilter is provided, the holding frame shall be arranged to accommodate Throw Away Filters as specified above. Frames shall be pre-punched to permit ready assembly into filter banks.
- 2.1.6 Filter media shall be No. 90 having an efficiency of 80-85% based on NBS or AFI dust spot method using atmospheric dust. Initial pressure drop at 2.54 m/s (500 fpm) face velocity shall not exceed 92 Pa (0.37" w.g.) and final 'replace' resistance shall be set at 199 Pa (0.80" w.g.).
- 2.1.7 Each cell shall be 610mm x 915mm (24" x 36") or 305mm x 915mm (12" x 36") as required to meet the specified face area of each filter bank.
- 2.1.8 Supply and install across each filter or filter bank, one Airflow Model PL7 'B' pack manometer for wall mounting. Unit shall have steel casing and zero adjustment knob. Scale shall be 127mm (5") long, reading 0mm to 25mm w.g. (0.0 to 1.0" w.g.).
- 2.1.9 Provide scale markings to indicate pressure drop at which filters are to be replaced.
- 2.1.10 Provide, for all air handling systems, all necessary filters for start-up, early use, balancing, and commissioning, including temporary blanket filters. Provide separate price for one (1) complete set of new filters on turnover of the equipment to the Owner.

3 **EXECUTION**

Not used.

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END OF SECTION

SECTION 23 57 50
GEOTHERMAL SYSTEM GENERAL REQUIREMENTS

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 23 57 55 – Vertical Closed-Loop Drilling and Grouting
- .2 Section 23 57 60 – Geothermal Distribution Piping
- .3 Section 23 57 65 – Geothermal Manifolds
- .4 Section 23 57 70 – Filling, Purging, Flushing, and Pressure Testing

1.2 REFERENCE STANDARDS AND REGULATIONS

- .1 ASTM International (ASTM)
 - .1 ASTM D3350-21, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
 - .2 ASTM F2164-21, Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure.
- .2 CSA Group (CSA)
 - .1 CAN/CSA-C448 Series-13 (R2015), Design and installation of earth energy systems.
 - .2 ANSI/CSA/IGSHPA C448-16 standards for commercial geothermal installations.
- .3 MECP O. Reg. 98/12

1.3 ABBREVIATIONS AND DEFINITIONS

- .1 ANSI – American National Standards Institute
- .2 ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers
- .3 Borehole – a drilled hole for the purpose of installing a geothermal U-loop and grout
- .4 Borehole Field – all U-loops, header circuits and main supply/return piping
- .5 Consultant – Salas O’Brien North, LLC.
- .6 Contractor – General Contractor

SECTION 23 57 50
GEOHERMAL SYSTEM GENERAL REQUIREMENTS

- .7 CSA – Canadian Standards Association
- .8 Distribution Piping – all buried lateral geothermal piping
- .9 HDPE – high density polyethylene
- .10 Header Circuit – U-loops and piping connecting individual U-loops in parallel reverse return configuration
- .11 IGSHPA – International Ground Source Heat Pump Association
- .12 Main Supply/Return Distribution Piping – the supply/return piping between each Header Circuit and the manifolds in the mechanical room or building
- .13 Manifolds – supply/return piping assemblies located in the mechanical room or building
- .14 MECP – Ministry of the Environment, Conservation and Parks
- .15 OBC – Ontario Building Code
- .16 OLS – Ontario Land Surveyor, licenced to practice professional surveying in Ontario
- .17 OHSA – Occupational Health and Safety Act
- .18 Owner – City of Toronto
- .19 SDR – standard dimension ratio
- .20 Subcontractor – Geothermal Subcontractor
- .21 U-Loop – high density polyethylene (HDPE) piping with a factory fused u-bend installed in vertical boreholes

1.4 PROJECT DESCRIPTION

- .1 The Consultant has been retained by Cherie Ng Architect Inc. to design a vertical closed loop geothermal system for the new East VSTS facility at Centennial Park.
- .2 The vertical boreholes will be connected via distribution pipes to geothermal manifolds.

SECTION 23 57 50
GEOTHERMAL SYSTEM GENERAL REQUIREMENTS

1.5 SCOPE OF WORK

- .1 Demarcation point – the main butterfly isolation valves at the supply and return manifolds located in the mechanical room.
- .2 U-loops – installed in each borehole (refer to drawings for quantity and depth of boreholes)
- .3 Header Circuits – lateral piping connecting all geothermal boreholes. All header circuit trench excavation and backfilling are included in the geothermal scope of work.
- .4 Main Supply/Return Piping – lateral piping connecting the header circuits into the mechanical room. All trench excavation and backfilling for this piping is included in the geothermal scope of work.
- .5 Geothermal Manifolds – supply and return manifolds located in the mechanical room.
- .6 Geothermal system filling, purging, flushing, pressure testing the U-loops and the borehole field piping, and charging the borehole field with the antifreeze solution.
- .7 Commissioning – entire borehole field including header circuits, geothermal manifolds, and instrumentation at manifolds.
- .8 Coordination with other disciplines, including architectural, civil, electrical, mechanical (includes controls), structural, and landscaping.
- .9 The Subcontractor shall report any contradictions or discrepancies in the specifications or drawings that may affect the work, prior to commencement. No allowance will be made after starting the work for any expense incurred through failure to conduct the examinations or failure to report any discrepancies in writing.

1.6 SUBCONTRACTOR QUALIFICATIONS

- .1 The Subcontractor must provide the following tender bid package:
 - .1 A copy of a current MECP issued Environmental Compliance Approval (ECA) in accordance with O. Reg. 98/12, including the associated Work Plan. The ECA must allow drilling to the specified depth in the geological deposits found at the site.

SECTION 23 57 50
GEOTHERMAL SYSTEM GENERAL REQUIREMENTS

- .2 Evidence of minimum 5-year company experience in compliant installation of commercial (non-residential), vertical closed loop ground heat exchangers, including detail of three (3) representative projects of similar size and complexity (minimum 50 tons in cooling capacity). Each project detail must include all of the following:
 - .1 Project name and address.
 - .2 Date work started and date completed.
 - .3 Brief description of work scope performed including project size.
 - .4 General Contractor/Construction Manager company name, contact name and phone number.
 - .5 Project Mechanical Engineer or Geothermal Engineer, with contact information and phone number.
- .3 Name and evidence of drilling company.
- .4 Name(s) of at least one Drilling Supervisor. If the Drilling Supervisor is not an employee of the Subcontractor, include a description of the relationship(s) between the Subcontractor and the Drilling Supervisor. Drilling Supervisor and Field Installation Supervisor can be the same person providing all qualifications are met. To obtain approval for Drilling Supervisor, the following criteria must be submitted:
 - .1 Evidence of a minimum of 5 years personal experience supervising or performing drilling and installation of vertical boreholes, closed-loop ground heat exchangers on commercial (non-residential) projects.
- .5 Name(s) of at least one Field Installation Supervisor. If the Field Installation Supervisor is not an employee of the Subcontractor, include a description of the relationship(s) between the Subcontractor and the Field Installation Supervisor. To obtain approval for Field Installation Supervisor, the following criteria must be submitted:
 - .1 Evidence of a minimum of 5 years personal experience supervising distribution piping, excavation, and testing of vertical closed loop ground heat exchanger projects larger than 50 tons in cooling capacity.
 - .2 Evidence of Fusion Technician qualifications as defined below.
- .6 For Fusion Technician qualifications, provide names and pipe manufacturer's certification for every field employee performing fusion techniques on this project. Evidence of current pipe manufacturer's installer certification or current IGSHPA Installer Accreditation are to be submitted for butt and socket fusion. Qualified Fusion Technicians must perform or directly supervise pipe fusions operations at all times.

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GEOTHERMAL SYSTEM GENERAL REQUIREMENTS

- .1 No Subcontractor employee shall perform pipe fusion related duties including, but not limited to, fusion tool maintenance or adjustment, pipe preparation, trimming, shaping and/or fusion, unless supervised by or personally qualified as a Fusion Technician as defined above.
 - .7 Name(s) and evidence of compliance for every Supervisor requested to be approved.
 - .2 The bidding firm shall conduct all work. Any sub-contractors proposed to work on the project must be identified and approved by the Consultant and the Owner. Identification must be provided in the tender bid package before the closing date, or the Notice of Recommendation to Award provided by the Owner.
 - .3 The Consultant and the Owner will review the Subcontractor Qualifications to determine if the Subcontractor is qualified to perform the required scope of work.
- 1.7 **LAWS, REGULATIONS, STANDARDS AND PERMITS**
- .1 The Subcontractor must perform all work in accordance with all applicable legislation and regulations, and the latest version of recognized industry Codes, Regulations, Standards and Guidelines, including, but not limited to the following standards and regulations:
 - .1 Ministry of Environment, Conservation and Parks (MECP) O. Reg. 98/12.
 - .2 International Ground Source Heat Pump Association (IGSHPA) best practices
 - .3 CAN/CSA-C448 Series 13 – Standards for commercial geothermal installations.
 - .4 ANSI/CSA/IGSHPA C448-16 – Standards for commercial geothermal installations.
 - .5 ASHRAE RP-1674, 2014, Geothermal Heating and Cooling (ISBN 978-1-936504-85-5)
 - .6 Ontario Building Code (OBC)
 - .7 Occupational Health and Safety Act (OSHA)
 - .8 Comply with all Federal, Provincial, and Municipal standards and regulations pertaining to the installation.
 - .2 The Subcontractor shall procure and pay for all permits, licences, inspections, or approvals necessary for the execution of the vertical closed loop geothermal system contract.

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- .3 The Subcontractor shall comply with all laws, ordinances, rules, orders, and regulations relating to the performance of the work, protection of property, maintaining of surface passageways to buildings, fences and/or other facilities.
- .4 The Subcontractor shall comply with all permit conditions imposed on the Owner by Federal, Provincial, and local laws.
- .5 All applicable Federal and Provincial laws, regulations, municipal ordinances, and the rules and regulations of all authorities having jurisdiction over the project shall apply to the Subcontractor throughout and they shall be deemed to be included in the contract as a part, therefore, the same as though herein described in full.
- .6 All regulations of the OHSA are in effect on this contract. It will be the Subcontractor's responsibility to make themselves aware of all appropriate Provincial and Federal regulations that apply to the contract.
- .7 Any violations incurred from improper execution of the above shall be paid by the Subcontractor. Loss of time on the project from such violations will not be tolerated.

1.8 ENVIRONMENTAL CONSIDERATIONS

- .1 The Subcontractor shall be fully responsible for the vertical drilling operation.
- .2 The Subcontractor shall take all measures necessary to protect surrounding public and private property, structures, buildings, roads, utilities, driveways, sidewalks, and appurtenances from damage due to the drilling work. Responsibility and payment for correction of such damage shall be the sole responsibility of the Subcontractor.
- .3 Vertical drilling is to be performed in a manner to eliminate the discharge of water, drilling fluid and cuttings to nearby waterways. The Subcontractor shall provide equipment and procedures to maximize the recirculation or reuse of drilling fluid to minimize waste. If inadvertent returns of drilling fluids near a structure or into a waterway occur, the Subcontractor shall immediately provide environmental controls and clean up to the satisfaction of, and at no additional expense to, the Owner.
- .4 When working adjacent to waterways, the general work area on the entry and exit sides of the crossing shall be enclosed by a berm to contain unplanned spills or discharge.

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GEOTHERMAL SYSTEM GENERAL REQUIREMENTS

- .5 Equipment (graders, shovels, etc.) and materials (such as groundsheets, silt fences, hay bales, booms, and absorbent pads) for cleanup and contingencies shall be provided in sufficient quantities by the Subcontractor and maintained at the site for use in the event of inadvertent leaks, seeps, or spills.

1.9 CONSULTANT SITE VISITS

- .1 During the installation of the geothermal system, the Consultant will perform site observations. The Subcontractor shall accommodate the Consultant's site visits.

1.10 EXTENDED WARRANTY

- .1 HDPE piping
 - .1 50-year manufacturer's warranty.
 - .2 Warrant that the piping is free from defects in material.
- .2 Geothermal System
 - .1 For entire geothermal system, the warranty period is 24 months.
 - .2 Warrant that the system is free from defects in material and workmanship.

Part 2 Geologic Setting

2.1 OVERBURDEN

- .1 The overburden in the vicinity of the site includes clay, silt, sand, gravel, and glacial till.
- .2 The overburden in the vicinity of the site is expected to be in the range of 1.5 m to 3.5 m deep.

2.2 BEDROCK

- .1 The bedrock in the vicinity of the site is shale with interbeds of limestone, extending to a depth of approximately 125 m. Below this formation, the bedrock consists of limestone with shale interbeds to a depth of over 275 m.

SECTION 23 57 50
GEOHERMAL SYSTEM GENERAL REQUIREMENTS

2.3 NATURAL GAS CONDITIONS

- .1 Shale bedrock contains organic material that can generate natural gas, which is trapped within the rock's pores. As a result, natural gas could be encountered during drilling at the site.

2.4 GROUNDWATER CONDITIONS

- .1 The shale bedrock at the site does not contain significant aquifers. However, the drilling process may encounter water flow rates of ~ 1 l/s.

END OF SECTION

SECTION 23 57 55
VERTICAL CLOSED-LOOP DRILLING AND GROUTING

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 23 57 50 – Geothermal System General Requirements
- .2 Section 23 57 60 – Geothermal Distribution Piping
- .3 Section 23 57 65 – Geothermal Manifolds
- .4 Section 23 57 70 – Filling, Purging, Flushing, and Pressure Testing

1.2 DESCRIPTION

- .1 The Subcontractor shall visit the site to review all conditions that could have an impact on their work.
- .2 The Subcontractor is responsible for all work included in this specification.

1.3 SCOPE OF WORK

- .1 This section includes the following items:
 - .1 drilling geothermal closed loop boreholes,
 - .2 installing the U-loops and grouting the boreholes, and
 - .3 pressure and flow testing the individual U-loops.
- .2 The Subcontractor must include all labour, materials, and equipment necessary to complete the items described in this specification.

1.4 QUALITY CONTROL

- .1 The Subcontractor must have a current MECP Environmental Compliance Approval (ECA) in accordance with O. Reg. 98/12. The ECA must allow drilling to the design depth of the boreholes in the geological deposits found at the site.
- .2 The Subcontractor must have an approved Drilling Supervisor on-site at all times during the drilling, U-loop installations, and borehole grouting. The Drilling Supervisor shall have adequate industry standard personal experience supervising or performing geothermal drilling, U-loop installations and grouting on commercial projects.
- .3 All HDPE fusion work shall be conducted by a qualified Fusion Technician. The Technician shall provide proof of training/retraining in butt, socket, and electrofusion procedures, and must perform all pipe fusion operations. No

SECTION 23 57 55
VERTICAL CLOSED-LOOP DRILLING AND GROUTING

Subcontractor employee may perform pipe fusion related duties, unless personally qualified as a Fusion Technician.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 The Subcontractor shall provide submittals in accordance with *Submittal Procedures*, found in Section 01 of the contract documents.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications, and datasheets.
- .3 Shop Drawings:
 - .1 Shop drawings shall include drawings, diagrams, schematics, material specifications and literature, which must be provided by the Subcontractor to describe the details of this section of the work.
 - .2 All shop drawings shall be submitted promptly to the Consultant for review and approval before commencing the U-loop installation and grouting.
 - .3 The shop drawings shall include explanatory notes on the method of U-loop installations, grouting and testing.

Part 2 Products

2.1 BOREHOLE U-LOOP PIPING

- .1 The borehole U-loop piping shall be made from high density polyethylene (HDPE) and specifically designed for geothermal closed loop systems.
- .2 The geothermal piping shall be manufactured from virgin HDPE resin with a cell classification of 445574C, or equivalent, as per ASTM D3350.
- .3 The geothermal piping shall meet the CAN/CSA-C448 Series 13 standards for geothermal energy systems and be marked with the "CSA" logo, as well as "C-448".
- .4 All U-loops shall have factory printed lengths on the sidewall, with zero on one end and the actual total length on the other end.
- .5 The U-bend on each geothermal U-loop shall be factory fused and pressure tested at a minimum of 275 kPa (40 psi) for one hour at the factory. The U-loops shall be pressurized at a minimum of 275 kPa (40 psi) before shipping to the site.

SECTION 23 57 55
VERTICAL CLOSED-LOOP DRILLING AND GROUTING

- .6 Check and record the factory applied pressure in the U-loop prior to removal of pipe ends and insertion into the borehole, to ensure it has not lost any pressure.
- .7 The U-loop piping shall have a standard dimension ratio of 11 (SDR 11), with nominal diameter as per drawings.
- .8 The piping shall be manufactured from PE 4710 resin with a pressure rating of 1280 kPa (200 psi).
- .9 Acceptable U-loop manufacturers include:
 - .1 Versaprofiles (<http://www.versaprofiles.com/en>)
 - .2 Trinus Pipes and Tubes Ltd. (<http://trinuspipes.com/>)
 - .3 International Pipe (<http://www.internationalpipe.ca/>)

2.2 WATER SUPPLY

- .1 The Subcontractor is responsible for obtaining potable water as necessary to perform the work.

2.3 GROUT

- .1 The geothermal boreholes shall be sealed completely with a high solids bentonite-based grout.
- .2 The thermal conductivity of the grout shall be a minimum of 2.08 W/(m-K) [1.20 Btu/(hr-ft-°F)].
- .3 Graphite composite shall be added to the bentonite grout in order to achieve the required thermal conductivity. The manufacturers' recommendations must be followed when adding this material to the bentonite.
- .4 The grout mixture shall comply with all MECP drinking water regulations.
- .5 The Subcontractor shall submit shop drawings for the grout mixture to the Consultant before commencing the drilling.

SECTION 23 57 55
VERTICAL CLOSED-LOOP DRILLING AND GROUTING

Part 3 Execution

3.1 PREPARATION

- .1 The Subcontractor shall hire and pay for the services of an OLS surveyor to accurately locate the field coordinates and existing surface elevation of all boreholes prior to the start of drilling.
- .2 The Subcontractor may use their own survey equipment to locate the boreholes, provided that they use control points surveyed by an OLS surveyor, and their crew are trained and competent in surveying techniques.
- .3 An OLS surveyor shall survey the location of each installed U-loop, to record accurate as-built locations. A copy of the surveyed U-loop locations shall be submitted to the Consultant.

3.2 DRILLING

- .1 The Subcontractor shall drill all geothermal boreholes to the target depth indicated on the drawings, below the bottom of the header trenches.
- .2 The drilling depth from the existing grade elevation must account for the difference between the elevation of the existing grade and the final elevation of the header circuit trench bottom.
- .3 The boreholes shall have a diameter of no greater than 125 mm (5 inches) in the bedrock formation, and a diameter of no greater than 175 mm (7 inches) in the overburden formation.
- .4 The Subcontractor shall obtain all necessary utility locates (public and private), prior to commencement of drilling activities.
- .5 The drilling will be conducted in such a manner and using such materials as to create no contamination risk to groundwater or the surface environment.
- .6 The Subcontractor must be aware of the local geological drilling conditions to the target depth from the test borehole, local water well records and geotechnical test holes on the site, as well as geological mapping in the vicinity of the site. Reliance on the test borehole log only (regarding the anticipated drilling conditions) is not permitted. The Subcontractor shall be aware of the typical geological and hydrogeological conditions found in the vicinity of the project site, to the design depth of the geothermal boreholes.

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VERTICAL CLOSED-LOOP DRILLING AND GROUTING

- .7 A temporary steel casing may be installed in the overburden, however it shall be removed after installation of the U-loop and grouting of the borehole.
- .8 Only potable water may be used for drilling purposes.
- .9 Spill containment materials shall be provided at the location of each drill rig, compressor and support equipment fuelling operations.

3.3 U-LOOP INSTALLATION

- .1 Prior to installation in the borehole, the U-loop shall be visually inspected for damage. The U-loop shall not be installed in the borehole if damage is observed.
- .2 The geothermal U-loop shall be installed with minimal delay after completion of the drilling.
- .3 The geothermal U-loop shall be installed to the design borehole depth below the header circuit trench.
- .4 The U-loop depth shall be within 3% of the design borehole depth, however the average depth for all boreholes shall equal the specified total number of boreholes multiplied by the specified depth of each borehole below the header circuit trench.
- .5 The Subcontractor shall confirm the depth of each installed U-loop by inserting a depth measurement gauge to the bottom of all U-loops, and recording the depth of the U-loop. A copy of all the recorded U-loop depths shall be submitted to the Consultant.
- .6 The geothermal U-loop shall be filled with clean potable water prior to insertion in the borehole.
- .7 Prior to the U-loop installation, the pipe ends shall be sealed with temporary plugs.
- .8 Care shall be taken to avoid kinking of the U-loop during its installation into the borehole. If the U-loop is kinked during installation, it shall be discarded.
- .9 At the completion of the flow and pressure testing (see Items 3.5 and 3.6), each U-loop shall be plugged and made visible above ground to reduce the potential for damage caused by construction activities in the area.

SECTION 23 57 55
VERTICAL CLOSED-LOOP DRILLING AND GROUTING

3.4 BOREHOLE GROUTING

- .1 The grouting material shall be mixed in strict accordance with the manufacturers' mixing instructions.
- .2 The grouting material shall be pumped into the borehole using a positive displacement pump and shall be mixed using a paddle type mixer.
- .3 The grouting material shall be installed from the bottom to the top of the borehole in a single continuous operation, using a tremie pipe which has been installed to the full depth of the borehole.
- .4 The tremie pipe shall be installed simultaneously with the U-loop.
- .5 Once grouting proceeds, the tremie pipe shall be raised slowly, as the grout mixture is introduced.
- .6 The tremie pipe shall be continuously submerged in the grout mixture at all times.
- .7 During removal of the temporary steel casing (if used) from the borehole, the grout will settle into the full diameter of the open borehole. Additional grout shall be added to the borehole to fill this space. The following steps shall be used to achieve this:
 - .1 During removal of the temporary steel casing, the tremie line shall be periodically re-inserted below the grout level and grout shall be pumped through the tremie line until it is observed at the top of the borehole. The grout shall not be allowed to drop below the bottom of the steel casing at any time.
 - .2 Continue this procedure until all but 3 m of the temporary steel casing is removed from the borehole.
 - .3 The tremie line shall be re-inserted into the final 3 m of temporary steel casing in the borehole, and grout shall be pumped until it is observed at the top of the borehole.
 - .4 The tremie line shall be re-inserted into the borehole after all temporary steel casing has been removed, and grout shall be pumped until it is observed at the top of the borehole.
- .8 Once the grout has set-up for a minimum of 48-hours, the drilling Subcontractor shall ensure that each borehole is filled with grout to the existing ground surface by "topping up", as necessary.

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VERTICAL CLOSED-LOOP DRILLING AND GROUTING

- .9 A grout sample shall be taken from each borehole and be made available to the Consultant for further observation. Samples selected by the Consultant shall be submitted by the Subcontractor to the grout manufacturer/supplier for thermal conductivity testing. A report on the grout thermal conductivity results shall be submitted to the Consultant.

3.5 U-LOOP IN-SITU PRESSURE TESTING

- .1 Fused pressure caps with Schrader valves shall be installed on both ends of each U-loop.
- .2 Each U-loop shall be pressure tested at a pressure of 690 kPa (100 psi) for one hour, after allowing time for expansion of the U-loop piping.
- .3 The pressure shall not drop more than 20 kPa (3 psi) after one hour.

3.6 U-LOOP FLOW-TESTING

- .1 All U-loops shall be flow tested at a flow rate of 0.63 L/s (10 US gpm) and the results provided to the Consultant.
- .2 The differential pressure loss across each U-loop shall be measured to confirm that there are no blockages. The differential pressure should be ~46 kPa (15.5 feet of head) at 0.63 L/s (10 US gpm), assuming 10°C water temperature with no antifreeze solution present. The Subcontractor must provide a flow meter and two pressure gauges that have been calibrated within the past 6 months.
- .3 Water in the U-loop shall not be allowed to freeze during winter operations.

3.7 SITE CLEANLINESS

- .1 The Subcontractor shall take all necessary precautions to protect the site surrounding the completed boreholes from any damage resulting from the drilling operations or work by other trades.
- .2 All drilling fluids and cuttings shall be contained in temporary pits or holding tanks during the drilling operations. Prior to completion of the geothermal work, all solids and liquids remaining in the temporary pits or holding tanks shall be removed from the site, and disposed at a suitable off-site facility. All temporary pits shall be backfilled with compacted, approved fill material in accordance with the project geotechnical consultant requirements.

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3.8 U-LOOP PROTECTION

- .1 The Subcontractor shall protect the completed U-loop installations from damage (eg - install a 2 m long, 100 mm diameter, PVC sleeve on each U-loop immediately after installation of the U-loop).
- .2 The Subcontractor shall submit their procedure for protecting the U-loops to the Consultant for review prior to commencement of the work.

3.9 REPORTING BOREHOLE DETAILS

- .1 The Subcontractor shall prepare borehole logs, including the following information:
 - .1 A drill log, including information about each geological formation encountered.
 - .2 The depth of each change in overburden deposits.
 - .3 The total number of batches of the grout mixture placed into each borehole, including the volume of each batch.
 - .4 The details of the grout mixture (examples: water volume, quantity of bentonite, quantity of thermally enhanced additives)
 - .5 Average penetration rate for the overburden deposits in m/minute.
 - .6 The total time to drill each borehole, excluding downtime.
 - .7 The U-loop in-situ pressure and flow test results.
- .2 The above logs shall be recorded, immediately upon completion of each task and submitted to the Consultant.
- .3 The results of the grout thermal conductivity tests shall be provided, as indicated in Part 3.4.9.

3.10 CLOSEOUT SUBMITTALS

- .1 Provide the Consultant as-built drawings of the location of each installed U-loop, as determined by an OLS surveyor.

END OF SECTION

SECTION 23 57 60
GEOTHERMAL DISTRIBUTION PIPING

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 23 57 50 – Geothermal System General Requirements
- .2 Section 23 57 55 – Vertical Closed-Loop Drilling and Grouting
- .3 Section 23 57 65 – Geothermal Manifolds
- .4 Section 23 57 70 – Filling, Purging, Flushing, and Pressure Testing

1.2 DESCRIPTION

- .1 This section describes the specifications for installing the supply and return geothermal distribution piping between each borehole U-loop and the supply/return manifolds in the mechanical room.

1.3 SCOPE OF WORK

- .1 This section includes the following items:
 - .1 layout and configuration of the geothermal distribution piping,
 - .2 trenching requirements,
 - .3 pipe connections,
 - .4 interim pressure testing before burial, and
 - .5 pipe bedding and backfill.
- .2 The Subcontractor must include all materials, equipment, and labour necessary to complete the items included in this section.
- .3 This scope of work includes the borehole field piping installation up to and including the supply/return manifolds in the mechanical room. The Subcontractor shall report any contradictions or discrepancies in the specifications or drawings that may affect the work, prior to commencement. No allowance will be made after starting the work for any expense incurred through failure to conduct the examinations or failure to report any discrepancies in writing.

1.4 QUALITY CONTROL

- .1 The Subcontractor must have an approved Field Installation Supervisor on-site at all times during the distribution piping installations. The Field Installation Supervisor shall have adequate industry standard personal experience

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supervising or performing geothermal piping installations on commercial projects.

- .2 All HDPE fusion work shall be conducted by qualified Fusion Technicians. The Fusion Technicians shall provide proof of training/retraining on butt, socket, and electrofusion procedures, and must perform all pipe fusion operations. No Subcontractor employee may perform pipe fusion related duties unless personally qualified as a Fusion Technician.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 The Subcontractor shall provide submittals in accordance with *Submittal Procedures*, found in Section 01 of the contract documents.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications, and datasheets.
- .3 Shop Drawings:
 - .1 Shop drawings shall include drawings, diagrams, schematics, material specifications and literature, which must be provided by the Subcontractor to describe the details of this section of the work.
 - .2 All shop drawings shall be submitted promptly to the Consultant for review and approval before commencing the distribution piping installation.
 - .3 The shop drawings shall include explanatory notes on the method of distribution piping installations and testing. Details on the trench excavations, trench backfilling and compaction, including any proposed deviations from the requirements of this section, shall be provided by the Subcontractor.

Part 2 Products

2.1 DISTRIBUTION PIPE

- .1 The Subcontractor shall provide new HDPE piping, as indicated in this section.
- .2 All distribution header pipes shall be PE 4710. Pipe wall thickness shall be as per the drawings.
- .3 All joints on the distribution piping shall be fused (heat fusion or electrofusion).

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- .4 All pipe and heat fused materials shall be manufactured from a virgin polyethylene extrusion compound material. Pipe shall be manufactured to outside diameters, wall thicknesses and respective tolerances as specified in ASTM D-3035, D-2447, or F 714.
- .5 The material shall be PE 4710 HDPE with minimum cell classification 445574C, with a UV stabilizer of C, D, or E as specified in ASTM D3350 and is listed by the Plastic Pipe Institute in PPI TR-4 with HDB ratings of 1,600 psi (11,000 kPa) at 73°F (23°C) and 1,000 psi (6,900 kPa) at 140°F (60°C). Resistance to environmental stress cracking is critical to long life expectancy. Therefore, as a more stringent requirement, the piping shall experience zero failures (F0) after 5,000 hours under condition "C" (100% reagent at 100 degrees C) when tested in accordance with ASTM D1693.
- .6 All pipes shall meet the requirements of CSA Standard B137.1 and CAN/CSA-C448 Series 13 Series standards for commercial geothermal installations.
- .7 The following marking information shall be shown on the pipe:
 - .1 Name of manufacturer,
 - .2 Pipe diameter,
 - .3 Pressure rating,
 - .4 SDR dimension,
 - .5 PE 4710,
 - .6 CSA C448/B137.1,
 - .7 Cell classification, and
 - .8 Date of manufacture.
- .8 The distribution piping shall include a 50-year manufacturer's warranty in writing.

2.2 PIPE FITTINGS

- .1 All specifications listed above for the distribution piping, shall apply to the heat-fusion fittings and they shall meet the requirements of ASTM D2683 (for socket fusion) or ASTM D3261 (for butt fusion).
- .2 The distribution piping shall include a 50-year manufacturer's warranty.

2.3 TRENCH BEDDING

- .1 The trench bedding shall be sand, pea stone or self-compacting engineered fill.

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2.4 PIPE SEAL FOR WALL AND FLOOR PENETRATIONS

- .1 Link-Seal hydrostatic sealing system shall be used for sealing all wall penetrations and floor slab penetrations.

2.5 PIPE LOCATION SYSTEM

- .1 The pipe locating system shall consist of 14-gauge copper tracer wire.

2.6 RIGID INSULATION (EXTRUDED POLYSTYRENE BOARD INSULATION)

- .1 Extruded polystyrene board; ASTM C578; with either natural skin or cut cell surfaces, and the following characteristics:
 - .1 Basis of Design:
 - .1 DuPont de Nemours Inc.; DuPont™ Styrofoam™ Brand SM30 Insulation.
 - .2 Compressive Strength, ASTM D1621: 207 kPa (30 PSI) minimum.
 - .3 Complies with CAN/ULC S701.1:2017 – Standard.
 - .4 Flame Spread Index (FSI): 300 or less.
 - .5 Smoke Developed Index (SDI): 700 or less.
 - .6 RSI-value of 0.88 (R-value of 5) minimum per 25 mm (1 inch) of material at 22°C (72°F).
 - .7 Panel Size: 51 mm (2") thick by 610 mm (24") wide by 2,438 mm (96") long.
 - .8 Board Edges: butt edge.
 - .9 Recycled Content: Average of 20% pre-consumer certified by UL Environment Inc.
 - .10 Sustainability: Third party listed Environmental Product Declaration certificate.
 - .11 Water Absorption: ASTM C272, 0.3% max by volume, with 96 hour water immersion.

2.7 MISCELLANEOUS MATERIALS

- .1 Warning Tape:
 - .1 Warning tape shall be a minimum of 75mm (3") wide, 4 mil inert plastic film 3" to 6" in width specifically formulated for prolonged use underground.
 - .2 The tape shall have metallic content to enable location by metal detectors.

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- .3 Tape shall be a continuous imprinted message repeated every 406mm to 914mm (16" to 36") warning of the installation buried below. The message shall read "CAUTION GEOTHERMAL PIPES BURIED BELOW."
- .1 Any other forms of tracer wire or materials must be pre-approved by the engineer.
- .2 Spray Polyurethane Foam:
 - .1 A closed cell spray polyurethane foam shall be used, which can expand and provide a water resistance in coring applications for pipe or tracer wires.
 - .2 Spray polyurethane foam is to be safe in contact with HDPE and PVC piping materials. No petroleum based products are to be in contact with HDPE pipe.

Part 3 Execution

3.1 GENERAL

- .1 Perform all installations pertaining to this section in accordance with current manufacturer's published instructions.
- .2 Prior to any excavations or trenching, all buried utilities, drainage, and irrigation systems shall be located and flagged by an appropriate utility locating firm.
- .3 Prior to arrival at site, all excavating equipment and tools shall be clean and free from potential contaminants, such as grease, oils, leaking gasoline or any other substances which could be construed as a contaminant.
- .4 All fuel transfers shall be carefully monitored, and any fuel spills, leaks or drips shall be immediately reported to the Owner and remediated. Air compressors should use in-line filters to remove oils.
- .5 The Subcontractor shall take all reasonable precautions to prevent damage to property both visible and concealed.
- .6 Final clean-up must be completed prior to final site reviews. No refuse of any variety shall be buried on the site.

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3.2 DISTRIBUTION PIPING LAYOUT AND PLANNING

- .1 The distribution piping layout shall be in accordance with the contract drawings. Any modifications to the piping layout shall be approved by the Consultant.
- .2 All supply and return header pipes shall be separated by at least 600 mm. Provide 50 mm rigid insulation with a minimum RSI of 1.76 (R10) suitable for burial, when lateral clearances between supply and return header pipes cannot be maintained.
- .3 Provide 25 mm rigid insulation with a minimum RSI of 0.88 (R5) suitable for burial, for vertical separation of all supply and return pipe crossings less than 300mm.
- .4 Provide 50 mm rigid insulation with a minimum RSI of 1.76 (R10) suitable for burial, when the lateral clearance between structural features (eg – concrete footings, floor slabs, duct banks, etc.) and the geothermal piping is less than 1.2m.
- .5 For geothermal piping outside the building, encase the piping in insulation with a minimum RSI of 1.76 (R10) suitable for burial, when it is located within 1.5 m of any structural component.
- .6 Provide 50 mm rigid insulation with a minimum RSI of 1.76 (R10) suitable for burial, when the lateral clearance between water or drainage pipes and the geothermal piping is less than 1.5 m.
- .7 In order to minimize hydraulic head losses in the distribution piping, 90° fittings may be replaced with bends or other fittings, subject to approval by the Consultant.
- .8 Where the geothermal piping passes through internal or perimeter foundation walls, the sleeves will be provided by Structural. The Subcontractor shall install link seals around all header piping that is installed through these sleeves. Link seals are required at both ends of each sleeve.
- .9 Where the geothermal piping passes through floor slabs, PVC Sch 80 sleeves shall be provided by the Subcontractor for pre-installation in the concrete forms or floor slab (by the Contractor), at the appropriate locations. The Subcontractor shall install link seals around all distribution piping that is installed through the floor slab, at both ends of each sleeve.
- .10 Where the geothermal piping passes below a grade beam, PVC Sch 80 sleeves shall be provided by the Subcontractor for the width of the grade beam. Both

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ends of each sleeve shall be filled with spray polyurethane foam for a complete seal between the distribution piping and the sleeve. Refer to the document PPI TN-69 (2023), 'Recommendations when Applying Spray Polyurethane Foam Insulation On and Around Plastic Pressure Pipes & Fittings', from the Plastics Pipe Institute (PPI) for installation guidance.

3.3 TRENCHING

- .1 Sheathing and shoring shall be done as necessary for protection of work and personnel safety, ensuring OHSA requirements are satisfied.
- .2 The trench locations and construction shall be coordinated with the site services contractors (water, drains, electrical, etc.).
- .3 In case the trenching work takes place during the winter months, the Subcontractor shall take all necessary precautions in order to prevent trenches and stockpiled backfilling material from freezing (eg – use of hydronic ground heaters).
- .4 The header circuit and main supply/return piping trenches shall be excavated to the depth shown on the drawings, from the final grade to the top of header pipes.
- .5 All trenches shall be open-cut and wide enough to allow 600 mm (2 feet) separation between the supply/return piping, as well as 150 mm (6 inches) separation between trench walls and any distribution piping, unless shown otherwise on the construction drawings.
- .6 The Subcontractor shall provide minor surface grading to prevent surface water runoff from flowing into open trenches.
- .7 All excavating equipment shall be clean and free of grease, oils, and leaking fuels. Fuelling operations shall be done in a dedicated area of the site that is equipped with spill containment materials.
- .8 Excavated material that is suitable for backfilling shall be piled a sufficient distance from the trench banks to avoid overloading and collapse. If unsuitable backfill material, such as organic deposits, waste material, building rubble, boulders, contamination, etc. is encountered, the Subcontractor shall immediately notify the Consultant, prior to continuing the excavation and backfilling works.
- .9 The sequence of trenching must be carefully coordinated with the other project contractors to avoid conflicts.

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3.4 DISTRIBUTION PIPE AND PIPE BEDDING MATERIAL INSTALLATION

- .1 Throughout the pipe installation process, the ends of all distribution pipe shall be capped until they are installed, all couplings shall be stored in covered containers until ready for use, and all fusion tools and supplies shall be kept clean.
- .2 Prior to installing the distribution pipes, a 150 mm layer of the specified bedding material shall be placed on the bottom of all trenches.
- .3 The bedding material shall be compacted in accordance with the Geotechnical Report.
- .4 The project geotechnical consultant shall conduct appropriate compaction tests on the bedding material.
- .5 The bedding material shall not be frozen, or placed in a trench that is frozen.
- .6 The header pipes shall be delivered to the site in bundles of straight lengths, and handled by methods approved by the manufacturer. The pipes shall be laid on the prepared trench bedding. Local depressions in the grade of the bedding shall be corrected to prevent differential settlement of the pipe.
- .7 In preparation of pipe joining, the joints shall be cut, as recommended by the pipe manufacturer, and aligned carefully on the trench bedding.
- .8 The number of points where the supply and return headers cross one another shall be minimized.
- .9 Ensure all open ends of the installed header pipe are capped to prevent entry of soils and debris (tape capping is not acceptable).

3.5 PIPE JOINTS

- .1 All distribution piping must be joined by heat fusion methods.
- .2 Polyethylene butt or socket fusions are acceptable. Saddle fusions are only acceptable when they are fabricated under factory conditions by approved manufacturers. No field fusion using saddle fittings is approved.
- .3 The Subcontractor shall have available on-site the following tools:
 - .1 pipe cutting device,
 - .2 chamfering tool,
 - .3 cold ring clamps,

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- .4 clean 100% cotton rags,
- .5 isopropyl alcohol,
- .6 timer device,
- .7 heating iron with built in thermometer,
- .8 temperature measuring device.
- .4 All HDPE pipes shall be chamfered and cleaned before fusion, with shavings removed. Refer to manufacturer's recommendations.
- .5 All joining materials and equipment shall be kept free of dirt, water, and other foreign materials. At completion of each stage of fusion work, a removable water-tight plug shall be installed on the open ends until connected to the next pipe.
- .6 The Subcontractor shall stage all pipe fusion work with due consideration of the time required for site visits by the Consultant, and time to pressure test completed segments of the distribution piping, prior to backfilling.

3.6 INTERIM PRESSURE TESTING

- .1 All completed segments of the header piping will be subject to rigorous pressure testing procedures before backfilling of the trenches can proceed. The pressure testing procedures referred to in CAN/CSA-C448 Series 13 shall be followed, in accordance with ASTM F2164.
- .2 The Subcontractor shall submit detailed pressure testing procedures that conform as close as possible to the standards and take into account special requirements for winter testing. The pressure testing submittals shall be part of the required shop drawings.
- .3 The following minimum pressure testing procedures are required when portions of the header piping must be buried before the entire circuit is completed:
 - .1 A hydrostatic, or low-pressure air, test must be completed on each header segment that requires interim backfilling in accordance with the following two options:
 - .2 Option 1 - Air-Pressure Test
 - .1 Low pressure air-testing is only capable of detecting visual leaks.

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- .2 The header segment shall be pressurized to a safe level with air, and each fusion joint and pipe segment shall be visually inspected for leaks. The visual inspection shall include the following:
 - .1 dry all fusion joints and pipe segments and inspect for water leaks;
 - .2 spray all fusion joints with soapy water and inspect for bubbling caused by air leaks;
 - .3 listen for the sound of air releases;
 - .4 All necessary safety precautions shall be taken when working with compressed air; and
 - .5 CAUTION: If low-pressure air testing is conducted in place of hydrostatic testing, there is an increased risk of missing a potential leak. All costs associated with repairing any leaks are the responsibility of the Subcontractor.
- .3 Option 2 - Hydrostatic Pressure Test
 - .1 The hydrostatic pressure test duration shall be 2 hours.
 - .2 In preparation of the pressure testing, the open ends of each header circuit must be capped with a fused assembly or reusable metal fittings capable of holding a minimum pressure of 830 kPa (120 psi).
 - .3 The pressure test assembly shall include a valve, pressure gauge and a water line connection.
 - .4 In preparation for each hydrostatic pressure test, an initial purge operation is required, using clean potable municipal water, to remove air from the distribution pipes and U-loops that are being tested; the purge velocity shall be a minimum of 0.6 m/s (2 ft/s).
 - .5 Pressurize each header circuit to a pressure, and for a sufficient period of time, to fully expand the pipe. Maintain pressure on the pipe until it is fully expanded.
 - .6 Set the pressure to 690 kPa (100 psi) and record the date and time of the start of the 2-hour pressure test.
 - .7 Conduct a visual inspection of all fusion joints for leaks.
 - .8 Record the pressure after 2-hours. If the test pressure remains steady (within 3% of the target value), no leakage is indicated.
 - .9 All winter pressure testing operations will require the use of heating blankets and appropriate heaters to prevent freezing of the water in the header circuits being tested and damage to the piping.

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- .4 The Geothermal Subcontractor shall maintain a pressure test log of all field tests, as each segment is completed.
- .5 The Geothermal Subcontractor shall submit a copy of the pressure test log for all field tests to the Consultant.

3.7 TRENCH BEDDING, BACKFILLING AND COMPACTION

- .1 Upon successful completion of the distribution pipe pressure testing, the Subcontractor shall proceed with placement of the bedding material over the piping. The bedding material should be placed by hand around each U-loop connection and wherever pipes cross over each other. The bedding shall be placed and compacted.
- .2 The bedding material shall be compacted in accordance with the Geotechnical Report.
- .3 In the event the trench bedding becomes saturated due to runoff or rainfall, it will have to be adequately drained to achieve the required degree of compaction, subject to review by the geotechnical consultant.
- .4 No bedding material shall be placed in a frozen condition, or into a frozen trench.
- .5 Once the header pipe bedding is at least 150 mm over the piping, approved backfill material shall be placed in uniform layers. The backfill material shall be installed and compacted in accordance with the Geotechnical Report.
- .6 The site shall be rough graded at the completion of the work. All excess fill material from the trench excavations shall be spread smoothly over the site, subject to the review of the geotechnical consultant.

3.8 PIPE LOCATION SYSTEM

- .1 The Geothermal Subcontractor shall install the tracer wire above all borehole field piping, including the U-loops, header circuit piping and main supply/return piping, as shown on the construction drawings. The tracer wire for each circuit shall be one continuous wire with no connections underground to enable continuous location of each header circuit and shall terminate in the mechanical room. A separate tracer wire shall be provided for each of the header circuits.
- .2 Each tracer wire circuit and header circuit shall be labelled in the mechanical room according to its respective header circuit number, using a permanent tag.

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3.9 HEADER PIPE QUALITY CONTROL

- .1 The Subcontractor shall maintain appropriate quality control to assure compliance with all items in this section of the geothermal specifications.
- .2 After delivery, the pipe and fittings shall be stored under a cover.
- .3 The Consultant shall reserve the right to take random samples of completed fusion joints for examination, if necessary.
- .4 All piping must be protected from the entry of sediments and other contaminating material at all times.
- .5 All header piping that is installed and pressure tested during the winter must be drained to protect against freezing conditions.
- .6 The Consultant may, at any time, suspend any portion of the distribution piping installation when satisfactory workmanship is not being met.
- .7 Any pipe installations that have defective joints, or do not meet the requirements of this contract may be rejected, and shall be replaced at the Subcontractors' expense.

3.10 SITE VISITS

- .1 The distribution pipe installation, pressure testing, and backfilling of the trenches will be observed from time-to-time by the Consultant to assess general conformance of the work with the project specifications and drawings.

The Subcontractor will be responsible for providing the Consultant with weekly updates of their progress so that field visits can be coordinated.

3.11 SITE RESTORATION AND CLEANUP

- .1 Any damage caused by the Subcontractor during installation of the geothermal distribution piping shall be repaired to the satisfaction of the Consultant.
- .2 Protect area during excavation from excess runoff and erosion.
- .3 Protect pipe protrusions from damage until connections to building systems are installed.
- .4 After all header trenches have been backfilled, all excess backfill, excavated dirt, rubble and rocks shall be graded at a location specified by the General Contractor and/or be deemed as waste material.

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- .5 All waste material generated by the Subcontractor shall be removed from the site as determined by the General Contractor.

3.12 CLOSEOUT SUBMITTALS

- .1 The following As-Built Reports must be submitted to the Consultant prior to approval of final payment:
 - .1 fully surveyed and dimensioned site layouts showing the as-built locations of all buried piping and surveyed co-ordinates of all U-loops by an OLS surveyor;
 - .2 excavation depths;
 - .3 bedding and backfill placement;
 - .4 final depths of header piping;
 - .5 fittings used for all joints and connections;
 - .6 location of all pressure test point locations;
 - .7 location of all tracer wire; and
 - .8 the site layout of the borehole field shall be suitable for permanent display in the mechanical room.
- .2 The following Test Reports must be submitted to the Consultant prior to approval of final payment:
 - .1 all interim header circuit purging records;
 - .2 all interim header circuit pressure tests;
 - .3 all trench bedding and backfill compaction records; and
 - .4 all pressure monitoring results for each header circuit.

END OF SECTION

SECTION 23 57 65
GEOHERMAL MANIFOLDS

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 23 57 50 – Geothermal System General Requirements
- .2 Section 23 57 55 – Vertical Closed-Loop Drilling and Grouting
- .3 Section 23 57 60 – Geothermal Distribution Piping
- .4 Section 23 57 70 – Filling, Purging, Flushing, and Pressure Testing

1.2 DESCRIPTION

- .1 This section describes the specifications for installing the supply and return manifolds for the project, located in the mechanical room.

1.3 SCOPE OF WORK

- .1 Items covered in this specification include:
 - .1 location and layout of the manifolds,
 - .2 manifold specifications,
 - .3 valve details,
 - .4 instrumentation details, and
 - .5 installation details.
- .2 The Subcontractor must include all materials, equipment, and labour to complete the items included in this section.
- .3 The demarcation line between the geothermal system and the building mechanical system is the isolation valve on the end of the supply/return manifolds in the mechanical room. The Subcontractor is responsible for all work up to, and including, the demarcation point.
- .4 The Subcontractor shall report any contradictions or discrepancies in the specifications or drawings that may affect the work prior to commencement. No allowance will be made after starting the work for any expense incurred through failure to conduct the examinations or failure to report any discrepancies in writing.

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1.4 QUALITY CONTROL

- .1 The Subcontractor must have an approved Field Installation Supervisor on-site at all times during the manifold installations. The Field Installation Supervisor shall have adequate industry standard personal experience supervising or performing geothermal manifold installations on commercial projects.
- .2 All HDPE fusion work shall be conducted by qualified Fusion Technicians. The Fusion Technicians shall provide proof of training/retraining on butt, socket, saddle, and electrofusion procedures, and must perform all pipe fusion operations. No Subcontractor employee may perform pipe fusion related duties unless personally qualified as a Fusion Technician.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 The Subcontractor shall provide submittals in accordance with *Submittal Procedures*, found in Section 01 of the contract documents.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications, and datasheets.
- .3 Shop Drawings:
 - .1 Shop drawings shall include drawings, diagrams, schematics, material specifications and literature, which must be provided by the Subcontractor to describe the details of this section of the work.
 - .2 All shop drawings shall be submitted promptly to the Consultant for review and approval before commencing the distribution piping installation.
 - .3 The shop drawings shall include explanatory notes on the method of distribution piping installations and testing. Details on the trench excavations, trench backfilling and compaction, including any proposed deviations from the requirements of this section, shall be provided by the Subcontractor.
- .4 Engineered Shop Drawings:
 - .1 A qualified professional engineer registered or licenced to practice in the Province of Ontario shall be employed to design the support stands sized for the manifold elevation and suitable to hold the manifold weight.

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- .2 Engineered shop drawings stamped and signed by a professional engineer responsible for the work of this Section shall be submitted to the Consultant.
- .3 Shop drawings shall consist of design details, shop details, erection procedures and material lists. Indicate materials, core thicknesses, method of anchorage, cuts and drilled holes, reinforcement, accessories, and finishes.
- .4 Interfaces with the work of other Sections must be shown on the shop drawings.

Part 2 Products

2.1 MANIFOLD PIPE

- .1 The Subcontractor shall provide new HDPE piping, as indicated in this section.
- .2 All manifold piping shall be PE 4710. Pipe wall thickness shall be SDR 11 for 100 mm (4") diameter and SDR 11 for 50 mm (2") diameter.
- .3 All joints on the distribution piping shall be fused (heat fusion or electrofusion).
- .4 All pipe and heat fused materials shall be manufactured from a virgin polyethylene extrusion compound material. Pipe shall be manufactured to outside diameters, wall thicknesses and respective tolerances as specified in ASTM D-3035, D-2447, or F 714.
- .5 The material shall be PE 4710 HDPE with minimum cell classification 445574C, with a UV stabilizer of C, D, or E as specified in ASTM D3350 and is listed by the Plastic Pipe Institute in PPI TR-4 with HDB ratings of 1,600 psi (11,000 kPa) at 73°F (23°C) and 1,000 psi (6,900 kPa) at 140°F (60°C). Resistance to environmental stress cracking is critical to long life expectancy. Therefore, as a more stringent requirement, the piping shall experience zero failures (F0) after 5,000 hours under condition "C" (100% reagent at 100 degrees C) when tested in accordance with ASTM D1693.
- .6 All pipes shall meet the requirements of CSA Standard B137.1 and CAN/CSA-C448 Series 13 Series standards for commercial geothermal installations.
- .7 The following marking information shall be shown on the pipe:
 - .1 Name of manufacturer,
 - .2 Pipe diameter,

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- .3 Pressure rating,
 - .4 SDR dimension,
 - .5 PE 4710,
 - .6 CSA C448/B137.1,
 - .7 Cell classification, and
 - .8 Date of manufacture.
- .8 The manifold piping shall include a 50-year manufacturer's warranty.

2.2 FITTINGS

- .1 All specifications listed above for the manifold piping, shall apply to the heat-fusion fittings and they shall meet the requirements of ASTM D2683 (for socket fusion) or ASTM D3261 (for butt fusion).
- .2 The distribution piping shall include a 50-year manufacturer's warranty.

2.3 VALVES AND INSTRUMENTATION

- .1 Each manifold shall include the following components, as noted on the drawings:
- .1 Manifold Isolation Valves (75 mm and larger):
 - .1 Each manifold shall have a butterfly valve with a flanged connection separating the manifolds from the building loop piping.
 - .2 The butterfly valve is to be CSA certified or C-UL listed.
 - .3 A maximum pressure rating of 1,370 kPa (200 psi), based on temperature at 37.8°C (100°F).
 - .4 Bi-directional dead end service rating without a downstream flange required.
 - .5 The butterfly valves shall be suitable for dead end service and have the following:
 - .1 cast iron body,
 - .2 lug style,
 - .3 lead free,
 - .4 aluminum bronze disc,
 - .5 stainless steel top and bottom stems,
 - .6 EPDM sealing seats,
 - .7 upper and lower bushings made with copper,

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- .8 removable lever handle,
 - .9 extendable neck to clear insulation, and
 - .10 flanged connections.
- .2 Circuit Isolation Valves (50 mm and smaller):
 - .1 Each supply and return outlets to/from the manifolds shall have full port ball valves with gauge port, lever handle, and threaded NPT female connections.
 - .2 The ball valve is to be CSA certified or C-UL listed.
 - .3 A flow coefficient (Cv) of:
 - .1 200 or higher for 50 mm (2"),
 - .2 150 or higher for 38 mm (1.5"),
 - .3 100 or higher for 32 mm (1.25"),
 - .4 40 or higher for 25 mm (1"),
 - .5 20 or higher for 19 mm (0.75"), and
 - .6 10 or higher for 12 mm (0.5").
 - .4 A maximum pressure rating of 4,130 kPa (600 psi), based on temperature at 37.8°C (100°F).
 - .5 A temperature range of -40°C (-40°F) to 177°C (350°F).
 - .6 The ball valve shall have the following:
 - .1 brass body,
 - .2 brass stem or stainless steel stem,
 - .3 brass ball or stainless steel ball,
 - .4 full port type,
 - .5 lead free,
 - .6 PTFE plastic seat,
 - .7 fluoroelastomer rubber seal material,
 - .8 lever handle with vinyl jacket,
 - .9 threaded NPT female connections, and
 - .10 6 mm (1/4") gauge port, with threaded NPT female connection.
- .3 P/T (Pressure/Temperature) Test Plugs
 - .1 Brass plug with 6 mm (1/4") NPT threads, EPDM or neoprene valve core, knurled cap with cap strap. Use extended length plugs to clear insulated piping. Adaptors shall have 1/4" (6 mm) FPT connection for standard pressure gauges.

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2.4 PIPE INSULATION & JACKETS

- .1 Refer to mechanical specifications for insulations details regarding glycol piping, including insulation type and insulation thickness by pipe size.
- .2 Jacket requirements for the insulated glycol pipes to follow mechanical specifications.

2.5 MANIFOLD SUPPORTS

- .1 The supply and return manifolds shall be supported by two floor support stands, which are anchored to the slab floor.
- .2 The supports shall include a carbon steel base stand sized for the manifold elevation and suitable to hold the manifold weight.
- .3 Each manifold shall be adequately secured to the floor supports.
- .4 The support stand shall be designed and stamped by a Professional Engineer.

Part 3 Execution

3.1 MANIFOLD INSTALLATION

- .1 P/T (Pressure/Temperature) Test Plugs
 - .1 Install in piping systems as indicated on the drawings and/or details. Do not insulate over test plugs.
- .2 Piping
 - .1 Piping shall be properly supported, and adequate provisions shall be made for expansion and contraction. Pipe shall be placed without springing, forcing or other interferences.
 - .2 All HDPE pipes shall be chamfered and cleaned before fused, per manufacturer's recommendations.
 - .3 All pipes shall be arranged to minimize interference with other trades or block access.
 - .4 Polyethylene butt or socket fusion is approved.
 - .5 Saddle fittings are approved only when fabricated under factory conditions by approved manufacturers.
 - .6 No field fusion utilizing saddle fittings is approved.
 - .7 Follow the manufacturer's written installation instructions.

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- .3 Manifold Installation
 - .1 The manifolds shall be installed after the mechanical room is constructed, at the locations shown on the drawings.
 - .2 The manifolds shall be installed on the steel floor support stands, as level as possible.
 - .3 All sections of the supply and return circuits containing valves and instrumentation shall be shop fabricated. These sections shall be attached to the manifold outlets and circuit piping, after the manifolds are in place.
 - .4 Each individual supply and return circuit shall be equipped with a metal labelled tag attached to the manifold outlets. The tag shall include the following information:
 - .1 circuit number, and
 - .2 "S" for supply and "R" for return
 - .5 The supply and return manifolds and all associated piping, valves, fittings, and appendages shall be insulated. The insulation of the manifolds shall match the requirements for the mechanical piping connecting to the manifolds (see the mechanical specifications for insulation details).
- .4 Cleaning And Protection
 - .1 During installation, ends of pipe shall be capped until pipe is joined to circuit.
 - .2 Leave adjacent paved areas broom clean.
 - .3 Clear debris, including excess backfill and excavated dirt and rock, from ground heat exchanger area.
 - .4 Protect area during excavation from excess runoff and erosion.
 - .5 Protect pipe protrusions from damage until connections to building systems are installed.

END OF SECTION

SECTION 23 57 70
FILLING, PURGING, FLUSHING, & PRESSURE TESTING

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 23 57 50 – Geothermal System General Requirements
- .2 Section 23 57 55 – Vertical Closed-Loop Drilling and Grouting
- .3 Section 23 57 60 – Geothermal Distribution Piping
- .4 Section 23 57 65 – Geothermal Manifolds

1.2 DESCRIPTION

- .1 This section describes specifications for filling, purging, flushing, and charging the geothermal piping with the antifreeze and water mixture.
- .2 This section also describes specifications for final pressure testing of the entire geothermal system at the supply/return manifolds.

1.3 SCOPE OF WORK

- .1 Items covered in this specification include:
 - .1 filling the geothermal system with water;
 - .2 purging the header circuits and U-loops to remove air;
 - .3 flushing the header circuits and U-loops to remove sediment and debris;
 - .4 hydrostatic pressure testing of the entire geothermal system; and
 - .5 charging the geothermal system with antifreeze.
- .2 The Subcontractor must include all materials, equipment, and labour to complete the items included in this section.
- .3 The Consultant shall witness and sign off on the hydrostatic pressure test of the entire geothermal system.
- .4 The Subcontractor shall report any contradictions or discrepancies in the specifications or drawings that may affect the work prior to commencement. No allowance will be made after starting the work for any expense incurred through failure to conduct the examinations or failure to report any discrepancies in writing.

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1.4 QUALITY CONTROL

- .1 The Subcontractor must have an approved Field Installation Supervisor on-site at all times during the filling, purging, flushing, and charging activities. The Field Installation Supervisor shall have adequate industry standard personal experience supervising or performing these tasks on commercial projects.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 The Subcontractor shall provide submittals in accordance with *Submittal Procedures*, found in Section 01 of the contract documents.
- .2 The following documents shall be submitted for review to the Consultant prior to starting the work:
 - .1 The method of filling the geothermal system and the source of water to be used;
 - .2 A flushing and purging plan, equipment specifications and the pumping equipment capacity required to meet the specified flow velocities in every flow path in the geothermal system;
 - .3 A procedure to conduct a final pressure test of the entire geothermal system;
 - .4 Records of the following:
 - .1 fill record,
 - .2 purging record,
 - .3 flushing record,
 - .4 pressure test record, with witnessed pressure readings, and
 - .5 antifreeze charging record.

Part 2 Products

2.1 PUMPING UNIT

- .1 The Subcontractor shall use a custom-built pumping unit to fill, purge, and flush the header circuits and U-loops. The unit shall be equipped with the following components:
 - .1 a pump capable of pumping at velocities of up to 1.5 m/s (5 ft/s) in all header circuits, in both directions;

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- .2 an open-top water storage tank or tanks, with inlets and outlets a sufficient distance to allow air to come out of the solution and minimize the recirculation of all air;
 - .3 a filter system to prevent the reintroduction of flushed debris into the header circuit;
 - .4 the filter system shall include a 5 micron filter (higher micron filters should be used during initial startup, with final filtering at 5 micron);
 - .5 capability to reverse the flow (without having to disconnect), by the use of valves;
 - .6 a water flow meter, which is calibrated to 2% accuracy; and
 - .7 a pressure gauge on both the supply and return lines.
- .2 The pump curve for the pumping unit shall be submitted to the Consultant for approval, prior to starting the process.
 - .3 The Subcontractor shall perform a field test of the pumping unit to verify the pumping capacity.

2.2 WATER SUPPLY

- .1 The Subcontractor shall be responsible for obtaining a source of potable municipal water for initial filling of the geothermal system. The source of the water shall be subject to approval by the Consultant. The Subcontractor shall submit a laboratory analysis (general chemistry, including metals) of the proposed water source (testing parameters will be provided by the Consultant).

Part 3 Execution

3.1 SYSTEM FILLING

- .1 The header circuits shall be filled by pumping the municipal water into each main supply/return header through the assembly at the supply/return Manifolds.

3.2 SYSTEM PURGING

- .1 Each header circuit shall be purged individually at the supply/return manifolds, at a flow velocity of 0.6 m/s (2 ft/s) in all borehole field piping, in order to remove all air.
- .2 The flow direction through each circuit shall be reversed 2 times, with the flow in each direction being about equal.

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- .3 The purging process shall continue until the water in the storage tank has no visible air bubbles.
- .4 A record of the flow rates, the time that flow reversals occurred, the pressure measurements and the time for complete air removal shall be kept for each circuit.

3.3 SYSTEM FLUSHING

- .1 Each header circuit shall be flushed individually at the supply/return manifolds, at a flow rate of 1.5 m/s (5 ft/s) in all borehole field piping, in order to remove sediment and debris in the U-loops and header piping.
- .2 The flow rate, and pressure reading at the supply and return pipe ends, shall be measured using calibrated instruments, and provided to the Consultant for review.
- .3 The flushing procedure for each header circuit shall continue until the water starts to clear.
- .4 Reverse the flow and continue the flushing operation. Reversing the flow ensures that any debris in the system that may be lodged in tight locations or resting places has an opportunity to move in the appropriate direction and be flushed out. It may be necessary to reverse the flow several times to remove all sediments and debris.
- .5 The flushing process will be considered complete when the water is sediment-free, and no turbidity is present.
- .6 A record of the time required to flush each circuit shall be kept, as well as an estimate of the quantity of sediment and debris that is removed from the system. The records shall be submitted with the As-Built document.

3.4 WATER QUALITY

- .1 After completion of flushing and purging all the header circuits, a sample of the water shall be submitted by the Subcontractor to an independent accredited test laboratory to confirm water quality. (Testing parameters will be provided by the Consultant and will include general chemistry and metals.) The testing record shall be submitted with the As-Built document.

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3.5 SYSTEM PRESSURE TEST

- .1 A final 24-hour hydrostatic pressure test of each header circuit shall be done at the supply/return Manifolds, following the purging and flushing. The pressure test method shall follow the procedure referenced in ANSI/CSA/IGSHPA C448.3-16 and described in ASTM F2164. The procedures outlined in the Plastic Pipe Institute's (PPI) technical document No. TN-46/2013 on Guidance for Field Hydrostatic Testing of HDPE piping shall also be followed.
- .2 The Subcontractor shall conduct the final pressure testing prior to installation of the concrete slab above the borehole field and header circuits being initiated.
- .3 The hydrostatic pressure tests shall be carried out on each circuit as follows:
 - .1 Close the main isolation butterfly valves (at the demarcation point) on the supply and return header pipe located on their respective manifolds and connect the hydrostatic pressure line to the flush ports.
 - .2 Pressurize each header circuit to a pressure, and for a sufficient period of time, to fully expand the pipe. Maintain pressure on the pipe until it is fully expanded.
 - .3 Reduce the pressure to 690 kPa (100 psi) and record the date and time of the start of the 24-hour pressure test.
 - .4 Record the pressure after 24-hours. If the test pressure remains steady (within 3% of the target value), no leakage is indicated.
 - .5 If leakage is indicated, it will be necessary to bring the pressure back to 690 kPa (100 psi) and check for potential leaks in the circuits, pressure gauges and fittings by visual inspection.
 - .6 Conduct further field testing to locate the cause and location of the leak in the affected circuit using a soap and water mixture. After the cause of the leak is found and corrected, the hydrostatic pressure test must be repeated.

3.6 FINAL ANTIFREEZE CHARGING

- .1 After completion of the final system pressure testing, the geothermal borehole field shall be charged with antifreeze.
- .2 The antifreeze solution shall consist of 25% propylene glycol and 75% water and additives (eg – inhibitors, biocides, etc.).
- .3 The supplier of the antifreeze must certify that the manufacturer recommended inhibitors and biocides are added to the antifreeze, as required for the geothermal and building mechanical piping and equipment.

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- .4 NOTE: The Subcontractor must consult with the Mechanical Subcontractor to ensure that the antifreeze solution in the geothermal and building loops are from the same manufacturer.
- .5 The volume of 100% antifreeze (required to achieve the specified concentration) shall be pumped into the geothermal loop as a single slug, so that the water displaced does not contain antifreeze.
- .6 The Subcontractor is not responsible for charging the geothermal loop piping beyond the supply and return manifolds.
- .7 A record of the total volume of the actual geothermal loop piping installed and the volume of antifreeze added, shall be kept and submitted with the Subcontractor's As-Built Report.
- .8 NOTE: The antifreeze solution in the geothermal loop shall be well mixed throughout the system by the loop circulation pump(s), prior to handover of the system to the Owner.
- .9 After installation of the antifreeze in the geothermal loop system, the Subcontractor shall install locks on each manifold isolation valve. A temporary label shall be attached to advise that the geothermal system has been tested and filled with antifreeze. The locks and labels must be removed at system handover.

3.7 ANTIFREEZE CONCENTRATION TESTING

- .1 After the water antifreeze mixture has been circulated for a sufficient period of time by the geothermal circulation pumps, a sample of the fluid shall be submitted by the Subcontractor to an independent accredited test laboratory to confirm the following attributes:
 - .1 Antifreeze percentage by volume.
 - .2 Inhibitor concentration (if any).
 - .3 Biocide concentration (if any).
 - .4 Soil particulates in the solution.
 - .5 Metal particulates in the solution.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, and Section 20 00 50 Basic Materials and Methods, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the drawings and specified herein, including:

1.2.1.1 Packaged Rooftop Units

1.3 SUBMITTALS

1.3.1 Provide shop drawings for:

1.3.1.1 Packaged Rooftop Unit.

1.3.2 As a minimum provide the following information:

1.3.2.1 Shop drawings shall indicate unit dimensions, unit weight, required clearances, wall, door and base construction details, coil rack and drain pan details, isolation base detail, isolator selection, field connection details, damper details, lifting lug details, and trapping requirements for cooling coil condensate.

1.3.2.2 Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, metal gauges, and finishes of materials.

1.3.2.3 Provide fan curves with specified operating point clearly plotted.

1.3.2.4 Submit sound power levels for both fan inlet and outlet at rated capacity. Provide sound power levels at the inlet and outlet of the unit.

1.3.2.5 Submit product data of filter media, filter performance data, filter assembly, and filter frames.

1.3.2.6 Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

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1.3.3 Provide manufacturer's certification letter. Refer to Section 20 00 00 – General Requirements.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Base bid shall be as noted in the mechanical drawing schedule. For considerations of alternates, cost savings must be shown on the tender form at time of closing. Contractors shall be responsible for all cost for all trades associated with any substitutions.

2.1.2 The complete unit shall be cETLus listed.

2.1.3 The unit shall be ASHRAE 90.1-2016 compliant and labeled.

2.1.4 Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-410 Refrigerant and oil.

2.1.5 The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.

2.1.6 All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door.

2.1.7 Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.

2.1.8 Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values.

2.1.9 All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.

2.1.10 Warranty: The manufacturer shall provide 12-month parts only warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence at startup or six months after shipment, whichever occurs first.

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2.2 CASING

- 2.2.1 Unit casing has a double wall insulation with injected foam insulation application meets NFPA 90 requirements. The insulation system is resistant to mold growth in accordance with UL 181 and ASTM C1338 standardized test methods. Panel construction shall be double-wall thermally broken construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 2" thick with an R-value of 13.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 8.0 inches w.g.
- 2.2.2 The casing shall be designed to meet ASHRAE 111 class 6 (CL 6) at design pressure up to +/- 6 inches, where casing leakage [cfm/100 ft² of casing surface area] = CL x P^{0.65}).
- 2.2.3 Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 750-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.
- 2.2.4 Service doors shall be provided on the fan section, filter section, control panel section, and heating section in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
- 2.2.5 The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

2.3 FILTERS

- 2.3.1 Refer to drawing schedule for filter ratings
- 2.3.2 Shall consist of factory installed, low velocity, disposable 2- in. thick fiberglass filters of commercially available sizes.
- 2.3.3 Units can accept 2" or 4" filters and have a field convertible transition.

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2.3.4 Filters shall be accessible through an access panel; hinged panel with tool-less access.

2.4 OUTDOOR/RETURN AIR SECTION

2.4.1 Unit shall be provided with a Metal Mesh pre-filter in the outdoor air hood/section to prefilter large particulate to prevent early filter clogging.

2.4.2 Unit shall be provided with an outdoor air economizer section. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. Damper assemblies have a maximum leakage rate of 4 CFM/sq. ft at 1.0 in. of water gauge (iwg) when tested in accordance with AMCA Standard 500, and have a longevity of 60,000 damper opening and closing cycles. The unit provided economizer meets the damper leakage and life cycle requirements for ASHRAE 90.1-2019, 2018 International Energy Conservation Code ®.

2.4.3 Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for “free” cooling. If outdoor air is suitable for “free” cooling, the outdoor air dampers shall modulate in response to the unit’s temperature control system.

2.4.4 The control is capable of operating the economizer using dry bulb, single enthalpy, or dual enthalpy.

2.5 SUPPLY FAN

2.5.1 Supply and Return Fans

2.5.1.1 All fans shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional

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maintenance.

2.5.1.2 The fan motor shall be a totally enclosed electrically commutated motor that is speed controlled by the rooftop unit controller. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency. A phase monitor is to be provided on unit designed to protect 3 phase equipment from phase loss, reversal, imbalance, and low voltage. The phase monitor fault condition is indicated at the unit control panel, and the unit is placed into an emergency stop condition.

2.5.1.3 Exhaust Fan configurations are not allowed as alternate

2.5.1.4 The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

2.5.2 Fan airflow measuring

2.5.2.1 All Supply and Return Fans shall include a factory installed flow measuring station. Airflow needs to be readable through the unit controller and building automation system.

2.6 COOLING COIL

2.6.1 The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and a sloped drain pan.

2.6.2 The distributor tubes shall be sleeved or coated to provide longevity and protection from leaks.

2.6.3 The drain pan shall be stainless steel and designed to comply with ASHRAE- 62.1 double sloped requirements drain pan shall be provided with the cooling coil. The drain pan shall extend beyond the leaving side of the coil and underneath the cooling coil connections. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall be connected to a threaded drain connection extending through the unit base. Units with stacked cooling coils shall be provided with a secondary drain pan piped to the primary drain pan.

2.6.4 Insulation under the drain pan should be a closed cell structure to prevent moisture from wicking under the drain pan. Fiberglass is

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not allowed.

2.7 HOT WATER HEATING

2.7.1 The hot water coil has one or [two] row[s]. Primary surface is 1/2 in. OD copper tube, staggered in direction of airflow. Connections have 1/4 in. FPT drain plug on each connection. A structural galvanized steel casing protects the coil. The coil is circuited to provide free draining and venting through one vent and drain. Freezestat is provided to prevent coil freeze up. Access doors are provided for convenient access to the valve for maintenance and inspection

2.7.2 The coil shall have freeze protection and shall be controlled by the unit DDC controller. With the detection of a freeze condition the heating coil valve shall be driven fully open. The unit controller shall indicate an alarm.

2.7.3 Completed coil including headers, connections, and return bends are tested with 325 pounds compressed air under water. Coils are designed for operation at 250 psig design working pressure..

2.8 EXHAUST SYSTEM

2.8.1 To control building pressure modulate exhaust fan, modulating EA damper with fan, and external control.

2.8.1.1.1 Powered exhaust fan with modulating DA damper: A double width, double inlet (DWDI) forward-curved centrifugal exhaust fan is provided to exhaust building return air to relieve building static pressure. The fans operates at a constant volume and based on building static pressure. Exhaust airflow is modulated via a parallel-acting control damper. The EA dampers are sized for 100% of the exhaust airflow. An access door is provided on at least one side of the unit for fan and motor access.

2.8.1.1.2 Powered exhaust with VFD: A DWDI forward-curved centrifugal exhaust fan is provided to exhaust building return air to relieve building static pressure. Exhaust airflow is modulated via a factory-installed and commissioned VFD with the same nameplate horsepower as the exhaust fan motor. An access door is provided on at least one side of the unit for fan and motor access. Dual powered exhaust with VFD

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2.9 ENERGY RECOVERY WHEEL

- 2.9.1 The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction and does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable.
- 2.9.2 The wheel capacity, air pressure drop and effectiveness shall be AHRI certified per AHRI Standard 1060. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Heat Exchangers For Energy Recovery Ventilation Equipment.
- 2.9.3 The rooftop unit shall be designed with a track so the entire energy recovery wheel cassette can slide out from the rooftop unit to facilitate cleaning.
- 2.9.4 The unit shall have 2" MERV 7 filters for the outdoor air before the wheel to help keep the wheel clean and reduce maintenance. The ERW is energized briefly for cleaning and blocking protection if it has not been operated for extended periods. Filter access shall be by a hinged access door with ¼ turn latches.
- 2.9.5 The matrix design shall have channels to reduce cross contamination between the outdoor air and the exhaust air. The layers shall be effectively captured in aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belt(s) of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
- 2.9.6 Desiccant is either silica gel or molecular sieve and permanently bonded to the energy transfer media without the use of binders or adhesives, which may degrade desiccant performance. Desiccants not permanently bonded are not acceptable due to potential delamination or erosion of the desiccant from the energy transfer media. Desiccant is non-migrating nor does it dissolve or deliquesce in the presence of water or high humidity
- 2.9.7 Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim

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assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning.

2.9.8 Wheel bearings are permanently sealed and selected for a minimum 30 year L10 life of 400,000 hours. Bearings requiring external grease fittings or periodic maintenance are not acceptable

2.9.9 The control of the energy recovery wheel shall be an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed at the rooftop units DDC controller LCD display. All of these temperatures shall be made available through the BACnet interface.

2.9.10 The rooftop unit DDC controller shall provide frost control for the energy recovery wheel. When a frost condition is encountered the unit controller shall be capable of stopping or slowing down the wheel. When in the frost control mode the wheel shall be jogged periodically and not be allowed to stay in the stationary position.

2.10 ROOF CURB

2.10.1 A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 24" high and include a nominal 2"x4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb. The roof curb shall be approved by the National Roofing Contractors Association.

2.10.2 If units with digital scroll compressors are used instead of variable speed compressors, the installing contractor shall fill the roof curb with Roxul Safe and Sound Insulation and shall provide a picture of the curb prior to the unit being installed.

2.11 HUMIDIFIER

2.11.1 Steam dispersion panel consisting of a (one) Horizontal 304 stainless steel round header Supplying steam to a bank of closely spaced [12 in. For 25 ton to 50 ton, 6 in. For 60 ton, 3 in. For 70 ton to 80 ton] vertical tubes, As necessary to meet absorption distance requirements, and to reduce condensation losses.

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2.12 ELECTRICAL

2.12.1 Each unit shall be wired and tested at the factory before shipment. Wiring shall comply with CSA standards. All wiring shall be number coded per the electrical wiring diagrams. All electrical components shall be labeled according to the electrical diagram and be CSA recognized.

2.12.2 A terminal block shall be provided for the main power connection and a terminal board shall be provided for the low voltage control wiring. Knockouts shall be provided in the bottom of the main control panel for field wiring entrance. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit.

2.12.3 Each compressor and condenser fan motor shall be furnished with contactors and internal thermal overload protection. Supply fan motors shall be supplied with external overload protection.

2.12.4 A single non-fused disconnect switch shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle

2.13 CONTROLS

2.13.1 Each unit shall be equipped with a microprocessor based control system. The unit control system shall include all required temperature and pressure sensors, input/output boards, main microprocessor and operator interface. The unit control system shall perform all unit control functions including scheduling, unit diagnostics and safeties.

2.13.2 The DDC control system shall permit starting and stopping of the unit locally or remotely. A set of contacts shall be provided for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.

2.13.3 The unit control system shall have the ability to communicate with an independent Building Management System (BMS) via a direct BACnet communication connection. The independent BMS system shall have access to "read only" variables and "read & write" variables. Communications shall not require field mounting of any additional sensors or devices at the unit. The BMS system shall be

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capable of interacting with the individual rooftop controllers in the following ways:

- 2.13.3.1 Monitor controller inputs, outputs, set points, parameters and alarms
- 2.13.3.2 Set controller set points and parameters
- 2.13.3.3 Clear alarms
- 2.13.3.4 Reset the cooling and heating discharge air temperature set point
- 2.13.3.5 Set the heat/cool changeover temperature
- 2.13.3.6 Set the representative zone temperature
- 2.13.4 It will be the responsibility of the Systems Integrating Contractor to integrate the rooftop data into the BMS control logic and interface stations.
- 2.13.5 The controller shall have a 4 line x 20 character display with all information and instructions shown in plain English. A keypad shall allow information and controls to be accessed. The microprocessor shall have a programmable time clock, store current and past alarm conditions.
- 2.13.6 The display shall provide the following information:
 - 2.13.6.1 Unit status including # of stages or % capacity for fans, heating, cooling and economizer.
 - 2.13.6.2 Supply, return, outdoor, and space air temperature
 - 2.13.6.3 Duct and building static pressure; the control contractor is responsible for providing and installing sensing tubes
 - 2.13.6.4 Inverter compressor speed and refrigeration circuit pressures and temperatures
 - 2.13.6.5 Outside air damper position and economizer mode
 - 2.13.6.6 Cooling and heating changeover status
 - 2.13.6.7 Occupied, unoccupied, and dirty filter status
 - 2.13.6.8 Date and time schedules

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- 2.13.6.9 Alarm faults
- 2.13.7 The following set points shall be adjustable:
 - 2.13.7.1 Control mode (Off / Auto / Cool Only / Fan Only / Heat Only)
 - 2.13.7.2 Occupancy mode (Auto / Tenant Override / Occupied / Unoccupied)
 - 2.13.7.3 Changeover mode (return air, space temperature or network signal)
 - 2.13.7.4 Cooling and heating discharge air temperature control
 - 2.13.7.5 Compressor lockouts and timers
 - 2.13.7.6 Economizer changeover (enthalpy or dry bulb)
 - 2.13.7.7 Scheduling
 - 2.13.7.8 Building static pressure control
- 2.13.8 When heat recovery units are specified, the control of the energy recovery wheel shall form an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed on the rooftop units LCD display. All of these temperatures shall be made available through the BACnet interface.
- 2.13.9 The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure set point.
- 2.13.10 Supply air reset options shall include; return air temperature, outdoor air temperature, space temperature, airflow (VAV), network signal, external signal (1-5 vdc or 0-20 mA)
- 2.13.11 The controller shall be complete with night setback control. The controller shall use its internal time clock for scheduling and have an adjustable override timer. (The unit shall be supplied with a wall mounted space sensor with an override button for field installation).

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3.1 INSTALLATION

- 3.1.1 Provide components furnished as per manufacturer's literature.
- 3.1.2 Field power wiring shall be provided by Division 26 - Electrical. Provide certified wiring schematics to Division 26 – Electrical for associated equipment.
- 3.1.3 Field control wiring shall be provided by Division 25 – Integrated Automation. Provide certified control wiring schematics to Controls Contractor.
- 3.1.4 Install unit flat and level on roof curb in accordance with manufacturers' installation literature.
- 3.1.5 Install and wire all control accessories and power wiring to the unit.
- 3.1.6 Hot water coil piping shall terminate in the vestibule. Install control valve in the vestibule.

3.2 STARTUP SERVICE AND WARRANTY

- 3.2.1 Manufacturer shall furnish a factory trained service technician to perform the unit startup. Manufacturer shall provide instruction to the owner's personnel on the operation and maintenance of the unit. Factory technician to provide copy of startup log to owner and to demonstrate operation and maintenance to owners' representative. The warranty period shall commence at the date of initial startup and shall continue for a period of one (1) year not to exceed eighteen (18) months from shipment. Manufacturer's warranty shall include all parts and labour to install parts.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.3 SUBMITTALS

1.3.1 Submit manufacturer's specifications for heat pumps showing dimensions, weights, capacities, performance ratings, electrical characteristics, gauges and finishes of materials and installation instructions. This information should also include:

1.3.1.1 Wiring diagrams

1.3.1.2 Electrical requirements

1.3.1.3 Field piping and wiring connections

1.3.1.4 Control diagrams and specifications

1.3.1.5 Rated capacities

1.3.1.6 Accessories

1.3.1.7 Warranty information

1.3.1.8 A factory test report will be completed for each module and available upon request

1.4 QUALITY ASSURANCE

1.4.1 Products shall be designed, tested and rated in accordance with, and installed in compliance with, applicable sections of the following Standards and Codes:

1.4.1.1 AHRI 550/590 – Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle

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- 1.4.1.2 ANSI/ASHRAE 15 – Safety Code for Mechanical Refrigeration
- 1.4.1.3 ANSI/ASHRAE 34 – Number Designation and Safety Classification of Refrigerants
- 1.4.2 ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings except Low-Rise Residential Buildings.
 - 1.4.2.1 ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
 - 1.4.2.2 ANSI/NFPA 70 – National Electrical Code (N.E.C.)
 - 1.4.2.3 ASME Boiler and Pressure Vessel Code, Section VIII, Division 1
 - 1.4.2.4 OSHA – Occupational Safety and Health Act
 - 1.4.2.5 Manufactured in facility registered to ISO 9001
- 1.4.3 Heat pump shall be pressure-tested, evacuated, and fully charged with refrigerant and oil, and shall be factory operational run tested with water flowing through the vessels.
- 1.4.4 Heat pump manufacturer shall have a factory trained and supported service organization.
- 1.4.5 Manufacturer shall warrant all equipment and material of its manufacture against defects in workmanship and material for a period of eighteen (18) months from date of shipment or twelve (12) months from date of start-up, whichever occurs first.
- 1.5 ALTERNATES
 - 1.5.1 The manufacturer may submit alternate heat pump selections in addition to the specified heat pumps, including but not limited to variations in performance, and provision of VFD's.
 - 1.5.2 Include in any alternate submission all details required to compare alternates with specified heat pumps.
- 2 **PRODUCTS**
 - 2.1 GENERAL
 - 2.1.1 Heat pump to be factory-assembled with compressor, compressor motor, compressor motor controller, evaporator, condenser,

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controls, dryers (on each circuit), interconnecting unit piping and wiring, and indicated accessories. Fabricate heat pump mounting base with reinforcement strong enough to resist heat pump movement during a seismic event when heat pump is anchored to field support structure. Field removable (4 Pipe/6 Pipe) piping rack complete with 3 way modulating water valves, 2 way modulating and manual on/off water valves, factory mounted temperature sensors, and factory mounted water flow switches with quick disconnecting electrical plug for control wiring connections between the compressor section and the piping rack section.

- 2.1.2 Each Module shall be self-contained. Meaning a module can be completely removed from a bank of modules without impacting the balance of the system. Each module will connect to the header assembly independently, have independent electrical connection, and be capable of running in a temperature control mode with or without a building automation system.
- 2.1.3 Failure of any module in a bank will not affect the operation of any other module. Any circuit failure on a single module shall not affect the operation of the circuit.
- 2.1.4 Each module shall be capable of supplying chilled water or hot water. The modular system contains independent fluids loops that are never mixed for hot and cold load fluids and the source/sink fluid. The cold load fluid has a dedicated evaporator, the hot load fluid has a dedicated condenser and the source/sink fluid has a dedicated heat exchanger that operates as an evaporator or condenser depending on the operating mode. The single refrigeration circuit includes check valves and solenoid valves and actuated ball valves that directs flow to the relevant evaporator, condenser and/or source/sink heat exchanger.
- 2.1.5 Heat pumps shall be CSA approved and cUL listed, and meet all applicable laws and regulations of Municipal, Provincial, and Federal Authorities.
- 2.1.6 Unit shall meet the performance detailed in the heat pump Schedule at the ampacity and voltage provided in the schedule. Construction and ratings shall be in accordance with latest ARI Standard 590, ANSI/ASHRAE 15, CSA-B52 and ASME Code.
- 2.1.7 Unit shall meet the performance detailed in the schedule. Construction and ratings shall be in accordance with latest ARI Standard 550/590, ANSI/ASHRAE 15, CSA-B52 and ASME Code.

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- 2.1.8 Equipment shall meet efficiency standards of ASHRAE Standard 90.1
- 2.1.9 All listed acceptable heat pump manufacturers must be able to provide tested and catalogued data detailing unit performance under all specified heat pump operating modes (heat recovery mode, heat pump mode, heating mode, as applicable). Custom unit modifications made at the factory level, or on site, which do not form part of the standard catalogued performance data, will not be accepted.
- 2.1.10 The unit shall be as detailed herein and shall be completely factory assembled.
- 2.1.11 The heat pump shall be completely run tested at the factory. All operations, safeties, and starter functions shall be checked. The manufacturer shall provide documentation indicating the heat pump was factory tested.
- 2.2 CABINET
- 2.2.1 Unit panels, structural elements, control boxes and heavy gauge structural base shall be constructed of painted galvanized steel. Access panels shall be removable via stainless steel fasteners and retaining clips. All exposed sheet steel shall be coated with baked on powder paint to meet 500-hour salt spray test in accordance with the ASTM B117 standard.
- 2.2.2 As standard, heat pump components shall be housed in an acoustically treated enclosure designed specifically to reduce radiated noise transmission by a minimum of 6 db(A).
- 2.2.3 Spring vibration isolators shall be factory supplied for field installation.
- 2.3 COMPRESSORS
- 2.3.1 Construct heat pump using fully hermetic scroll type compressors with R-410A optimized and dedicated scroll profile.
- 2.3.2 Suction gas cooled motors operate at 3500 rpm protected by internal overload device.
- 2.3.3 Each compressor shall have Intermediate Discharge Valves (IDV) or variable volume ratio technology
- 2.3.4 Each compressor shall have overload protection internal to the

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compressor

- 2.3.5 Each compressor shall include: centrifugal oil pump, oil level sight glass and oil charging valve
- 2.3.6 Each compressor will have crankcase heaters installed and properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles.
- 2.3.7 Compressors shall be mounted to the steel frame with rubber-in-shear vibration isolators

2.4 EVAPORATOR AND CONDENSER

- 2.4.1 The water to refrigerant heat exchangers shall be single circuit water, copper-brazed 316 stainless steel channel plates, capable of withstanding 650 psig working pressure on the refrigerant side and 360 psig on the water side. Refrigerant circuits are separate with a common water supply. This provides optimal part load efficiency compared to using two single circuit heat exchangers. Heat exchangers are designed to work as an evaporator and condenser.
- 2.4.2 The water to refrigerant heat exchangers shall be dual circuit, copper-brazed 316 stainless steel channel plates, capable of withstanding 650 psig working pressure on the refrigerant side and 360 psig on the water side. Refrigerant circuits are separate with a common water supply. This provides optimal part load efficiency compared to using two single circuit heat exchangers. Heat exchangers are designed to work as an evaporator and condenser.
- 2.4.3 Heat exchangers are covered with 3/4" closed-cell insulation.
- 2.4.4 Water line connections attached to the heat exchangers have integrated paddle flow switches for proving flow before and during operation. The water line connections will also have isolation valves to isolate the individual heat exchanger without interrupting system operation for service and maintenance.
- 2.4.5 Heat exchanger will have a 2.5" flanged connection for direct building connection or to a factory header rack configuration.
- 2.4.6 Heat exchangers shall be designed, tested, and stamped in accordance with UL 1995.
- 2.4.7 Provide water drain connection, vent and fittings. Factory installed

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leaving water temperature control and low temperature cutout sensors.

2.4.8 Water connections shall be grooved pipe.

2.5 REFRIGERANT CIRCUIT

2.5.1 Heat pump parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

2.5.2 Unit shall utilize refrigerant type R-410A.

2.5.3 Unit shall be provided with factory installed electronic expansion valve (EEV) on each circuit (2/unit in total).

2.5.4 Unit shall have check valve in discharge gas outlet to prevent refrigerant back flow during shutdown.

2.5.5 Unit shall have refrigeration filter drier that is adequately sized for the circuit charge requirements.

2.5.6 Each circuit shall have suction and discharge pressure transducers that monitor the current pressures.

2.5.7 Provide the following for refrigerant circuit:

2.5.7.1 Liquid line shutoff valve

2.5.7.2 Discharge service valve

2.5.7.3 Filter

2.5.7.4 Liquid line sight glass.

2.5.7.5 Electronic expansion valve sized for maximum operating pressure

2.5.7.6 Charging valve

2.5.7.7 Reversing valve

2.6 WATERSIDE PIPING

2.6.1 Four Pipe Standard

2.6.1.1 Header assembly shall be independent of the heat pump module for installation and service. The header assembly should be isolatable from the module without interrupting the functionality of

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other modules.

2.6.1.2 Each module shall use its isolation valves to prevent flow from going through modules that are not currently in operation.

2.6.2 Four Pipe Reversing

2.6.2.1 Header assembly shall be independent of the heat pump module for installation and service. The header assembly should be isolatable from the module without interrupting the functionality of other modules.

2.6.2.2 Each module shall use its isolation valves to prevent flow from going through modules that are not currently in operation.

2.6.2.3 Header rack shall be capable of water side economizing functionality.

2.7 CONTROLS

2.7.1 The control panel shall contain a microprocessor controller providing operating and equipment protection controls, plus motor starting equipment. Controller shall be factory wired, operationally tested, and ready for operation. Standard components shall include a control transformer with primary and secondary fusing, microprocessor transformers with integral fusing, compressor contactors, circuit breakers, single-point wiring arrangement and switches for each circuit pump down and unit control power.

2.7.2 The control system shall stage the compressors based on the leaving water temperature.

2.7.3 Equipment protection devices include motor protection, high pressure, loss of refrigerant, loss of water flow, freeze protection, and low refrigerant pressure. Controls shall include auto/stop switch, chilled water set point adjustment, hot water set point adjustment, anti-recycle timer, and digital display with water temperature and set point, operating temperatures and pressures, and diagnostic messages.

2.7.4 The keypad/display shall provide access to all vital equipment data. Data shall include full description of current unit status, setpoint parameters, and alarms. Data shall be displayed in clear, precise English text. Programmable security password protection shall be provided.

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- 2.7.5 Control system shall monitor all system temperatures, pressures and safeties, and shall automatically shut down a refrigerant circuit or entire unit should a fault occur. All fault conditions shall be automatically time and date stamped, retained in memory and shall be available for display.
- 2.7.6 The DDC controller shall be equipped with a time clock to allow the user to program a daily or weekly schedule. The control system shall have auto-restart after power failure and not require battery back-up or auxiliary power supply for maintaining program memory. The microprocessor shall have a lithium battery time clock to automatically ensure correct time of day input after power failure. Once power is restored, the controller shall check for any other faults and if none are present, shall permit normal unit operation.
- 2.7.7 Microprocessor shall accept a 4-20 mA DC for resetting chilled water temperature and hot water temperature.
- 2.7.8 The microprocessor shall incorporate two short cycle time functions: start to start; and stop to start. These shall be specially programmed to provide the least amount of time off line while providing the maximum compressor motor protection.
- 2.7.9 During part load operation, the controller shall unload alternately between refrigeration circuits to maximize efficiency. On unit start-up, the microprocessor shall limit the rate at which chilled water loop temperature is pulled down. The pulldown rate shall be adjustable.
- 2.7.10 Controller shall provide output contact closure for control of chilled water, hot water or condenser water pump.
- 2.7.11 The heat pump shall be factory installed with a microprocessor based DDC controller capable of communications with any Building Automation System supporting BACnet, Modbus and LONMark communications protocol. The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list.
- 2.7.12 Standalone, non-communicating units are also available that will operate with thermostat, mechanical, or electronic signals. Temperature set mode is capable of controlling to leaving load temperature.

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2.7.13 Controls shall be compatible with 3rd party heat pump optimization software.

2.8 ELECTRICAL

2.8.1 Factory installed and wired, and functionally tested at factory before shipment

2.8.2 Single-point power connection to terminal block in a NEMA 1 control panel per module for complete redundancy

2.8.3 Breaker rotary-type thru door disconnect in control panel of each module.

2.8.4 Each compressor should have: Fuse protection, contactor, thermal overload, along with motor phase and temperature protection.

2.8.5 High pressure cut outs set at 550 PSIG with manual reset.

2.8.6 Low pressure cut outs set at 80 PSIG with manual reset

2.8.7 Heat pumps shall be 575/3/60.

2.9 ACCESSORIES

2.9.1 Strainers - Each header inlet will be supplied a 30 mesh Y-type strainer that connects between the heat pump bank and building connection. Integrated strainers in each module will not be allowed.

2.9.2 Temperature Headers - Pre-engineered temperature headers with temperature sensors will be supplied by the manufacture to be installed on the inlet and outlet header between the modular bank and the building connection. These temperature sensors shall be used for staging a bank of modular heat pumps.

2.9.3 Bypass Valves - The bank of heat pump modules shall utilize a pre-engineered bypass and temperature assembly. This bypass assembly shall be supplied by the heat pump manufacturer and installed between the heat pump outlet connections and the building connection. The bypass assembly will be controlled by the supervisory controller to prevent dead heading of pumps. A system bypass may still be needed to maintain minimum system or minimum pump flows. These bypasses shall be supplied, controlled, and installed by others.

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3.1 DELIVERY

- 3.1.1 Upon receiving equipment check for any sign of shipping damage.
- 3.1.2 Final locations of the heat pumps on the drawings are approximate, unless dimensioned. Determine exact locations before roughing-in piping and electrical work.

3.2 INSTALLATION

- 3.2.1 Install in accordance with manufacturer's instructions.
- 3.2.2 Comply with requirements for piping specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to heat pump to allow service and maintenance.
- 3.2.3 Connect each heat pump drain connection with a union and drain pipe, and extend pipe to floor drain.
- 3.2.4 A strainer must be installed before the inlet of the heat pump bank that is a minimum of 30 mesh.
- 3.2.5 The Master control requires an independent 120v electrical feed
- 3.2.6 The Master panel shall have a single BACnet MSTP wire ran to the heat pump bank and then daisy chained between the modules.
- 3.2.7 A buffer tank must be installed if the system volume does not meet the manufacturer's system requirements.
- 3.2.8 Provide valves in water piping upstream and downstream of the evaporator and condenser water connections for isolating the shells for maintenance and to balance and trim the system.
- 3.2.9 Provide pressure relief piping from relief valve to outside, in accordance with manufacturer's instructions and in compliance with CSA-B52 Mechanical Refrigeration Safety Code (latest version). Provide flexible connections between relief valve and relief piping.
- 3.2.10 Rig and install heat pumps in full accordance with Manufacturer's requirements, project drawings and contract documents.
- 3.2.11 Locate heat pump as indicated on drawings, including cleaning and service maintenance clearance per Manufacturer instructions. Adjust and level heat pump on support structure.

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- 3.2.12 Installing Contractor shall provide and install all auxiliary devices and accessories for fully operational heat pump.
- 3.2.13 Coordinate electrical requirements and connections for all power feeds with electrical contractor.
- 3.2.14 Coordinate all control requirements and connections with controls contractor.
- 3.2.15 Installing Contractor shall paint damaged and abraded factory finish with touch-up paint matching factory finish.

3.3 STARTUP SERVICE AND WARRANTY

- 3.3.1 Manufacturer shall furnish a factory trained service technician to perform the unit startup. Manufacturer shall provide instruction of the owner's personnel on the operation and maintenance of the unit.
- 3.3.2 Start-Up and Check-Out Procedures:
 - 3.3.2.1 Engage a factory-authorized service representative to perform startup service.
 - 3.3.2.2 Complete installation and startup checks according to manufacturer's written instructions
 - 3.3.2.3 Verify that refrigerant charge is sufficient and heat pump has been leak tested.
 - 3.3.2.4 Verify that pumps are installed and functional.
 - 3.3.2.5 Verify that thermometers and gauges are installed.
 - 3.3.2.6 Operate heat pump for run-in period.
 - 3.3.2.7 Check bearing lubrication and oil levels.
 - 3.3.2.8 For heat pumps installed indoors, verify that refrigerant pressure relief device is vented outdoors.
 - 3.3.2.9 Verify proper motor rotation.
 - 3.3.2.10 Verify static deflection of vibration isolators, including deflection during heat pump startup and shutdown.
 - 3.3.2.11 Verify and record performance of fluid flow and low temperature

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interlocks for evaporator and condenser.

- 3.3.2.12 Verify and record performance of heat pump protection devices.
- 3.3.2.13 Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- 3.3.2.14 Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.
- 3.3.3 Prepare test and inspection startup reports.
- 3.3.4 A four hour owners training shall be provided at the start up visit over the specific equipment installed.
- 3.3.4.1 The heat pump equipment supplier shall independently start-up, check-out and test all hardware and software and verify communication between all components.
 - 3.3.4.1.1 Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 - 3.3.4.1.2 Verify that all analog and binary input/output points read properly.
 - 3.3.4.1.3 Verify alarms and interlocks.
 - 3.3.4.1.4 Control interlocks and any miscellaneous sequences shall be tested.
 - 3.3.4.1.5 All alarm and shutdown modes shall be tested for proper operation.
- 3.3.4.2 The consultant and owner may elect to be present to observe and review these tests. They shall be notified at least ten (10) days in advance of the start of the testing procedures.
- 3.3.5 The warranty period shall commence at the date of initial startup and shall continue for a period of one (1) year not to exceed eighteen (18) months from shipment. Manufacturer's warranty shall include all parts and labour to install parts. Refrigerant shall not be included in the warranty.
- 3.3.5.1 Extended 3-year warranty on equipment (in addition to the 1-year) shall be provided as a separate price.

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END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Forced flow heaters

1.2.1.2 Air curtains

1.2.1.3 Radiant ceiling panels

1.2.1.4 Heat pumps

1.3 SUBMITTALS

1.3.1 Submit shop drawings for:

1.3.1.1 Forced flow heaters

1.3.1.2 Air curtains

1.3.1.3 Radiant ceiling panels

1.3.1.4 Heat pumps

1.3.2 As a minimum provide the following information:

1.3.2.1 Data sheets for hydronic terminals, showing rated capacities and sound power levels.

1.3.2.2 Drawings indicating dimensions, weights, required clearances, location and size of pipe connections.

1.3.2.3 Power and control wiring diagrams.

1.3.2.4 Provide manufacturer's certification letter. Refer to Section 20 00 00 – General Requirements.

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2 PRODUCTS

2.1 HORIZONTAL WATER-TO-AIR HEAT PUMPS

2.1.1 General

2.1.1.1 Units shall be supplied completely factory assembled, piped, internally wired, fully charged with Pure Single-Component R-32 refrigerant and capable of operation with an entering water temperature range from 20°F to 120°F on ground loop models. All equipment must be rated and certified in accordance with AHRI/ISO 13256-1 and must be tested, investigated, and determined to comply with the requirements of the standards for Heating and Cooling Equipment CAN/CSA-C22.2 NO. 60335-2-40 Version 2. Each unit shall be ETL and ETLC Listed. Each unit shall be run tested at the factory. The installing contractor shall be responsible for furnishing and installing Water Source Heat Pumps as indicated on the plans and per installation instructions. Units with zeotropic blend refrigerants are not acceptable. Extended range unit shall have insulated refrigerant-to-water heat exchanger and insulated water and refrigerant tubing; all designed to help prevent sweating.

2.1.2 Unit Construction

2.1.2.1 Unit cabinet shall be fabricated from heavy gauge G-60 galvanized sheet metal with interior surfaces lined with 1/2-inch thick, 1.5 lb., dual density fiberglass insulation. All insulation will have the edges sealed or tucked to prevent introduction of glass fibers into the air stream. Standard cabinet insulation must meet NFPA 90A/90B requirements and have a flame spread of less than 25 and a smoke developed classification of less than 50 per ASTM E-84 and UL 723. All air-side insulation shall conform to mold growth limits in accordance with UL-181, fungi resistance per ASTM C 1338 or ASTM G21 and shall meet zero level bacterial resistance per ASTM G22.

2.1.2.2 Units shall have a factory-installed, 4-sided, 1" duct flange on the discharge of the blower to allow connection of field ductwork and must have a minimum of three access panels, two for the compressor compartment and one for the blower compartment. Unit shall have an insulated panel separating the blower compartment from the compressor compartment.

2.1.2.3 Cabinets shall have separate openings and knockouts for entrance

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of line voltage and low voltage control wiring.

2.1.2.4 Units shall include factory-installed, one-inch-thick, 2-sided filter rack with a top and bottom filter rail for filter support with standard 1-inch thick disposable filter(s) and a ¾-inch fold-out duct collar for connection of return air ductwork. If units with these factory installed items are not used, the contractor is responsible for any extra costs to field install these provisions, and/or the extra costs for their sub-contractor to install these provisions.

2.1.3 Refrigeration System

2.1.3.1 Units shall have an R-32 sealed refrigerant circuit, which includes a rotary or scroll compressor, thermostatic expansion valve, an aluminum lanced-fin and rifled copper tube refrigerant-to-air heat exchanger, reversing valve and a coaxial, tube-in-tube, refrigerant-to-water heat exchanger. The coaxial coil shall be made of a copper inner tube and a painted steel outer tube and shall be deeply fluted to enhance heat transfer and minimize fouling and scaling. The coaxial coil shall have a working pressure of 500 psig on the waterside and 600 psig on the refrigerant side. The airside coils shall be rated at a minimum of 600 psig working pressure.

2.1.3.2 The compressor shall include thermal overload protection and have a dual level vibration isolation system. The compressor will be mounted on vibration isolation grommets to a heavy gauge compressor mounting plate, which is then isolated from the cabinet base with rubber grommets to minimize vibration transfer.

2.1.4 Fan Section

2.1.4.1 Fan and Motor Assembly - Unit shall have a direct drive centrifugal fan motor assembly. The fan housing shall have a removable inlet orifice ring to allow removal of the fan motor and fan wheel removal from one side without removing the entire fan housing. Units shall have a direct-drive centrifugal fan. The fan motor shall be constant torque electronically commutated for enhanced unit operation. Field adjustable CFM settings shall be accomplished from the position of 4-dip switch settings on the I/O expansion board located in the control box.

2.1.5 Electrical

2.1.5.1 The control box shall be located within the unit and shall contain controls for compressor, reversing valve, and fan motor operation and shall have either a 50VA or 75VA control circuit transformer,

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and a terminal block for low voltage field wiring connections. Unit control system shall provide heating or cooling as required by the set points of the wall thermostat or space sensor. The unit control scheme shall provide for fan operation simultaneous with compressor operation (fan interlock) regardless of the thermostat type. The unit shall include an alarm relay for providing an output signal to an LED on the thermostat or to a central monitoring panel to indicate a "fault" condition from the activation of any one of the safety devices. Unit shall include an electrical nameplate with markings to accept time delay fuses or HACR circuit breaker for branch overcurrent protection of the power source. All units shall have a Short-Circuit current rating of 5kA rms symmetrical, 600V maximum.

2.1.6 Condensate, Supply and return condenser water connections

2.1.6.1 Shall be FPT fittings securely mounted flush to the cabinet corner post allowing for connection to a flexible hose without the use of a back-up wrench. Condensate drain connection shall not be less than $\frac{3}{4}$ " FPT fitting securely flush mounted to the corner post. Supply, return, and condensate drain shall be connected to loop and drain piping as detail on mechanical drawings. Condensate drain connection shall not be less than $\frac{3}{4}$ " FPT fitting securely flush mounted to the corner post. Supply, return, and condensate drain shall be connected to loop and drain piping as detail on mechanical drawings. Piping connections at the unit which require brazing or soldering by the installer (which may damage the unit) shall not be allowed.

2.1.7 Drain Pan

2.1.7.1 Unit shall utilize a corrosion resistant, stainless steel insulated drain pan. A stub out connection shall be provided. The drain pan shall be internally sloped to ensure no pooling of condensate water per ASHRAE 62.2. Units without internally sloped drain pans will not be accepted. The unit will be supplied with solid-state electronic condensate overflow protection sensor as standard. Mechanical float switches will not be accepted.

2.1.8 Controls

2.1.8.1 Unit shall have a microprocessor-based control system for heating, cooling and fan operation plus random start time delay, compressor anti-short cycle protection, condensate overflow protection, high and low voltage protection, low pressure switch bypass timer, built-in unoccupied cycle from a remote signal, 2-

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hour override of the unoccupied cycle from a push button on the wall thermostat, built-in shutdown operation from a remote signal, silent reversing valve operation, LED diagnostic status display, optional auto reset of the safety switches, fan interlock, lockout alarm output and dry contact output for motorized valve.

2.1.9 Startup Service

2.1.9.1 Furnish the services of factory-trained representatives to supervise the installation, starting and testing in accordance with the manufacturer's instructions. Upon completion of the installation, the manufacturer shall provide, to the owner, a written report on the start-up of these units.

2.2 FORCED FLOW HEATERS

2.2.1 Units shall be complete with coil, fan, filter and motor assembly and casing.

2.2.2 Cabinet shall be constructed with 1.6mm (16-gauge) electro galvanized steel with removable front panel. Adequate work area for installation of control valves or electrical equipment shall be provided on both sides of the internal cabinet. The cabinet shall be provided with a baked enamel prime coat as standard. All cabinets shall be supplied with adjustable levelling legs and rear mounting brackets, which will provide adjustment to correct alignment of the unit at installation to non-square or out of true walls, joists, studs or surfaces.

2.2.3 Recessed units shall be supplied with a "Wall Seal" assembly. This assembly shall provide protection to the wall or ceiling construction material. The "Wall Seal" shall be supplied in an eggshell baked enamel prime coat as standard.

2.2.4 Filters shall be reusable aluminum media with a 69% arrestance level. Filters shall be slide-in type, which are locked into position.

2.2.5 Fan wheels shall be centrifugal, forward curved, double width of electro galvanized steel. Fan housing shall be of formed, galvanized sheet metal.

2.2.6 Motors shall have integral thermal protection and start at 78 percent of rated voltage. Motors shall be of PSC design and be capable of operating in high static conditions. Motors shall be factory run-tested and assembled in unit prior to shipping. Primary internal wiring shall be done at the factory and every unit shall be

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factory tested for reliability.

2.2.7 Provide each unit with a solid-state motor speed controller for infinite speed adjustment from high to low speed. On wall and floor mounted unit, the speed controller shall be factory mounted behind an access door. Provide a unit mounted line voltage thermostat for wall and floor units. Provide remote line voltage thermostat for ceiling hung units.

2.2.8 Install safety chains on ceiling hung units.

2.3 AIR CURTAINS

2.3.1 Refer to Mechanical Plans to verify type, size and location of all air curtains.

2.3.2 Shall come complete with BACnet capability to be connected to the BAS.

2.3.3 Bottom panel finish shall be custom colour to match ceiling. Architect to specify colour.

2.3.4 Air curtain shall be architectural recessed hot water heated air curtain with factory installed Intelliswitch digital controller and coil, high efficiency low noise Pro-V Nozzle, washable filter.

2.4 RADIANT CEILING PANEL

2.4.1 Refer to both Architectural and Mechanical Plans to verify type, size and location of all radiant panels.

2.4.2 Extruded aluminum panels shall have a corrugated face to promote radiant heat transfer and conceal joints between panels. Use DN15 (1/2") nominal pipe with a minimum wall thickness of 0.7mm (0.028 inches). Copper pipe shall be mechanically attached to the back side of the aluminum panels at the factory.

2.4.3 Specified panels widths are the minimum acceptable. Panels shall run continuously from column to column.

2.4.4 Provide joiner clips between each strip of panel. Joiner pieces shall be extruded aluminum with identical expansion coefficient to ensure a tight joint is maintained between strips.

2.4.5 Factory paint panels with a high temperature, high emissivity electrostatically applied powder paint coating. Colour shall match ceiling colour. Architect to specify colour.

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3 EXECUTION

3.1 GENERAL

3.1.1 Line side power wiring shall be provided under Division 26 - Electrical. Provide certified wiring schematics to the Division 26 - Electrical Contractor for associated equipment.

3.1.2 Field control wiring, including wiring for line voltage thermostats, shall be provided as part of the work of this Section.

3.2 HORIZONTAL WATER-TO-AIR HEAT PUMPS

3.2.1 Install horizontal heat pumps using hanger kit and rubber isolators provided by heat pump supplier.

3.2.2 Install all units neat and level following manufacturer's instructions.

3.2.3 Install flexible pipe ball valves and duct connections between heat pump units and piping/ductwork.

3.2.4 Field power wiring shall be provided by Division 26 - Electrical. Provide certified wiring schematics to Division 26 - Electrical for associated equipment.

3.2.5 Field control wiring shall be provided by Division 25 – Integrated Automation. Provide certified control wiring schematics to Controls Contractor

3.3 FORCED FLOW HEATERS

3.3.1 Install heavy-duty radiator valve on supply line and lock shield valve and air vent on return.

3.4 AIR CURTAINS

3.4.1 Install heavy duty valve on supply line and lock shield valve and air vent on return.

3.4.2 Coordinate with appropriate general trade responsible for ceiling system. Ceiling system shall support air curtains on edges.

3.5 RADIANT CEILING PANEL

3.5.1 Contractor shall ensure that the manufacturer supplies copper pigtails for joining panel sections and copper return bends for joining adjacent panel pipes. Contractor shall supply soft copper

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pipe for joining panel sections where the manufacturer's standard fittings cannot be used.

- 3.5.2 Contractor shall ensure the panel pipe closest to the perimeter is connected to the supply riser. The panel pipe furthest from the perimeter shall be connected to the return riser. Panel piping shall be interconnected to provide parallel flow between panels. Pipe shall not be connected for series flow between panels.
- 3.5.3 Provide dielectric couplings between steel and copper piping.
- 3.5.4 Pressure test all panel piping as specified in Section 23 21 13 – Hydronic Piping. Do not connect panel piping to distribution piping until the distribution system has been properly cleaned, flushed and filled.
- 3.5.5 Coordinate with appropriate general trade responsible for ceiling system. Ceiling system shall support radiant panels on edges. Provide safety hanger wires on 1.2m (4 ft) centres under this Section.
- 3.5.6 Radiant panels shall be field assembled with hardware and tools provided by the manufacturer. Cut and/or trim panels to length. Panels shall not be installed until perimeter wall and windows have been installed.
- 3.5.7 Install 25mm (1") thick fibreglass insulation on the backside of radiant panels.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 15000 - General Mechanical Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Chilled water cooling coils.

1.2.1.2 Hot water heating coils.

1.3 SHOP DRAWINGS

1.3.1 Provide shop drawings for:

1.3.1.1 All chilled water and hot water heating coils.

1.3.2 As a minimum provide the following information:

1.3.2.1 Data sheets for coils.

1.3.2.2 Physical outline dimensions showing piping connections.

2 **PRODUCTS**

2.1 COILS

2.1.1 Interior zone hot water reheat coils to be Trane type WS or T with dimensions as shown on the schedule, same end connection, with copper tubes, aluminum fins and galvanized casing.

2.1.2 Apparatus reheat and glycol heating coils to be Aerofin Type CH, same end connections, with DN15 (½") O.D. copper tubes, aluminum fins, steel headers, and galvanized casing. Coils shall be adequately braced and assembled to eliminate stratification.

2.1.3 Cooling coils to be Aerofin Type 'CD' drainable header chilled water coil with copper tubes, aluminum fins, steel headers and stainless steel casing.

2.1.4 Preheat coils to be Aerofin Type CH coils, same end connections

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with DN15 (½") O.D. copper tubes, aluminum fins, steel headers and galvanized casing.

- 2.1.5 Support suspended coils independently of ductwork with rod type hangers.
- 2.1.6 Coils must withstand working pressure of 1,379 kPa (200 psi) and test pressure of 2,068 kPa (300 psi). Coil capacity, size, pressure drops shall be as noted on the Drawings.
- 3 **EXECUTION**
 - 3.1 **INSTALLATION**
 - 3.1.1 Provide gasketed or caulked duct or casing connecting flanges on all coils designed to prevent bypassing of air.
 - 3.1.2 Install coils in equipment such as air handling units, ducts, condensers, etc. Enclose all other coils within a coil cabinet.
 - 3.1.3 Install drain and vent connections on all coils. Provide plugged valves on heating coil drain and vent connections.
 - 3.1.4 Pipe cooling coil drain pans to nearest drain. Provide deep seal trap, with seal depth not less than specified fan static pressure.
 - 3.1.5 Install duct reheat coils to permit removal. Provide access doors on upstream and downstream sides of coils.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Steam humidification system.

1.3 SHOP DRAWINGS

1.3.1 Submit shop drawings for steam humidification system.

1.3.2 As a minimum provide the following details:

1.3.2.1 Performance and design data including absorption distances.

1.3.2.2 Piping diagrams.

1.3.2.3 Data sheets showing capacities and rating method.

1.3.2.4 Arrangement drawing showing overall dimensions, clearance requirements, size and location of connections.

1.3.2.5 Control schematics with sequence of operation.

1.3.2.6 Sensing element type, manufacturer, model number and location.

1.3.2.7 Control panel layouts, terminal strip diagrams and wiring schematics showing size and location of connections.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Humidifier grid shall provide absorption characteristics that preclude water accumulation on any in-duct surfaces within the scheduled downstream distance from the humidifier. The absorption distance shall be at duct temperatures and relative humidity as scheduled. Provide computer verification of the absorption distance certified by the manufacturer.

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2.2 STEAM GENERATING HUMIDIFIERS

2.2.1 Sizing

2.2.1.1 Size all Steam Generating Humidifiers to produce an amount of steam equal to or greater than the actual humidification load and any steam that condenses within distribution piping and steam injection grids.

2.2.2 Construction

2.2.2.1 Vaporizing chamber, cover and fittings shall be constructed of 304 stainless steel with heli-arc welded seams.

2.2.2.2 The humidifier shall be capable of being field converted to run on either standard or demineralized water without being removed from the installation. This shall be accomplished through the use of a universal probe/float assembly and a software change.

2.2.2.3 The cover shall be secured by quick removal threaded knobs. The gasket shall be held in place by flanges that are formed as part of the cover and as part of the evaporating chamber. Flanges shall interlock in such a way that the sealing gasket is locked between them.

2.2.2.4 Provide tray to catch and hold minerals to facilitate periodic clean-out. Tray shall rest on the floor of the evaporating chamber. The scale shed by the heaters shall be caught in the tray. The tray shall be easily removed through the inspection opening.

2.2.2.5 Humidifier shall be covered with 20mm ($\frac{3}{4}$ ") thick, rigid, foil faced fibreglass insulation. Insulation shall be covered with reinforced aluminum foil. All surfaces under the removable heater access panel shall be covered.

2.2.2.6 Provide four support legs, of length to provide 610mm (24") between underside of humidifier and floor.

2.2.3 Water Level Control

2.2.3.1 Electronic Water Level Control for Hard or Softened Water shall provide for automatic refill, low water cut off and adjustable skimmer bleed-off functions. System shall consist of:

2.2.3.1.1 A water level sensing unit comprising three metallic probes screwed into a threaded probe head. Probe head shall incorporate probe skirts to eliminate short-circuiting between probes caused by mineral coating of probe head. Probe head shall be mounted on the top of the vaporizing chamber.

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- 2.2.3.1.2 A solenoid operated fill valve factory mounted on the front of the humidifier.
- 2.2.3.2 VAPOR-LOGIC microprocessor field adjustable surface skimmer/overflow shall be provided for optimum mineral removal with minimum water waste.
- 2.2.4 Controls
 - 2.2.4.1 Control Cabinet shall be ULC listed, NEMA-12 enclosure. Control devices shall be mounted on a removable sub-panel within the enclosure. Control devices shall include VAPOR-LOGIC microprocessor, magnetic contactor for each heater, control circuit transformer, fuse set for each heating stage, numbered terminal strip, other such devices as hereinafter specified and all interconnecting wiring. A wiring diagram shall be included and attached inside of cabinet door. Humidity sensors shall be field installed.
 - 2.2.4.2 The cabinet shall be factory attached to the side of humidifier with all interconnecting wiring factory provided.
 - 2.2.4.3 VAPOR-LOGIC microprocessor shall be factory mounted and wired in the humidifier control panel with humidity sensors shipped loose for field installation. Mounting instructions and a wiring diagram shall be included. Microprocessor shall provide the following functions:
 - 2.2.4.3.1 LED "heartbeat" fault indicator to perform software self-diagnosis at every start-up.
 - 2.2.4.3.2 Water make-up valve control and low water safety shutdowns.
 - 2.2.4.3.3 Auto drain/flush sequence whereby microprocessor accumulates actual humidifying "ON" time and activates auto drain/flush sequence.
 - 2.2.4.3.4 End of season drain function, which activates when there has been no demand for humidification over a 72-hour period.
 - 2.2.4.3.5 Four-position functional slide switch on microprocessor board with stops at, "AUTO", "STANDBY", "DRAIN", and "TEST".
 - 2.2.4.3.6 Equally cycled electrical contactors for long life.
 - 2.2.4.4 VAPOR-LOGIC Keypad/Digital Display Module shall be housed in a thermoplastic enclosure. Module shall be shipped loose for field mounting and shall provide the following features:
 - 2.2.4.5 The Alphanumeric Digital Display portion shall continuously scroll all system functions including:

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- 2.2.4.5.1 Actual room or space relative humidity (R.H.)
- 2.2.4.5.2 Humidistat set point R.H.
- 2.2.4.5.3 Duct R.H.
- 2.2.4.5.4 High limit humidistat set point R.H.
- 2.2.4.5.5 "Time until service" message.
- 2.2.4.5.6 High limit and air flow proving circuit condition.
- 2.2.4.6 The keypad portion shall enable the user to reset or adjust the following functions:
 - 2.2.4.6.1 Humidistat R.H. setpoint.
 - 2.2.4.6.2 Humidistat R.H. high limit setpoint.
 - 2.2.4.6.3 Auto drain/flush frequency interval.
 - 2.2.4.6.4 Auto drain duration.
 - 2.2.4.6.5 Auto flush duration.
 - 2.2.4.6.6 Proportional–integral–derivative (PID) loop.
 - 2.2.4.6.7 Throttling range adjustment.
 - 2.2.4.6.8 Time to go until next auto drain/flush sequence.
 - 2.2.4.6.9 Setting of cycle and delay times for proportional control device.
 - 2.2.4.6.10 Electronic skim timer.
 - 2.2.4.6.11 Humidity and temperature transmitter trim adjustments.
- 2.2.4.7 Provide the following to interface to the Building Automation System:
 - 2.2.4.7.1 Terminal blocks for remote Enable - Disable.
 - 2.2.4.7.2 N.O. and N.C. general alarm contacts.
 - 2.2.4.7.3 Terminal block for 4-20mA, 0-135 Ohms, 6-9 VDC signal from BAS to control the output of the humidifier.
- 2.2.4.8 Provide VAV Control Package. Two modulating electronic humidity sensors (one room or duct mounted upstream of humidifier, the other duct mounted downstream of the humidifier) shall be shipped loose for field

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installation. Each shall transmit its signal to the VAPOR-LOGIC microprocessor, which, in turn shall modulate the humidifier output thereby maintaining the highest duct humidity possible at all, airflow volumes, without saturation of the air stream.

- 2.2.4.9 Provide an airflow-proving switch, static pressure type diaphragm operated for field installation. Switch shall have an adjustable control point range of 12.5 Pa (0.05" w.c.) to 2,988 Pa (12" w.c.).

2.3 STEAM DISTRIBUTION

2.3.1 Rapid-Sorb Tube Bank

- 2.3.1.1 Furnish and install where indicated and of component sizes noted on the drawings RAPID-SORB tube banks. Tube bank shall consist of a horizontal header/separator and designated quantity of vertical dispersion tubes necessary to achieve the required steam capacity and absorption distance. Header and dispersion tubes shall be 304 stainless steel. Header/separator shall span the width of the duct and be fitted with nipples for dispersion tube connections. The dispersion tubes shall extend the height of the duct and shall be fitted with two rows of tubelets centered on the diametric line and spaced 38mm (1-½") apart. These tubelets shall be made of non-metallic material designed for steam temperatures. Each tubelet shall extend through the wall of and into the center of the dispersion tube and incorporate a properly sized calibrated orifice.

2.3.2 Alternation Distribution Grids

- 2.3.2.1 Dispersion tubes provided without tubelet inserts shall be provided with full width, 50mm (2") deep stainless steel drain pans extending 610mm (24") upstream and 1,220mm (48") downstream of the grid for grids mounted within air handling units, and 610mm (24") upstream and 3m (10 ft) downstream of the grid for grids mounted in ducts.

2.4 CONDENSATE TEMPERING

- 2.4.1 Provide a "DRANE-KOOLER" or approved equivalent condensate-tempering device to cool a maximum of 0.4 L/s (6.3 USgpm) of condensate from 100°C (212°F) to 60°C (140°F), when provided with 0.4 L/s (6.3 USgpm) of 20°C (68°F) or cooler city water at 138 kPa (20 psi) or more.

- 2.4.2 Mixing chamber and fittings shall be constructed of 304 stainless steel with welded seams. Include a self-contained brass-body

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tempering valve with temperature adjustment and charged bulb.

- 2.4.3 Provide a 20mm ($\frac{3}{4}$ ") brass-bodied, ball-type drain valve and a vacuum breaker.

3 **EXECUTION**

3.1 START-UP

- 3.1.1 Furnish the services of a trained representative of the equipment manufacturer to supervise the installation, wiring, set up and testing of the humidifier system. Upon completion of the installation, the manufacturer shall instruct a representative of the owner on the proper operation of the system.

3.2 INSTALLATION

- 3.2.1 Install humidifier in accordance with manufacturer's instructions.
- 3.2.2 Supply distribution manifolds to manufacturer of air handling unit for mounting by manufacturer. Refer to Section 23 72 00 – Energy Recovery AHUs.
- 3.2.3 Install all accessories provided with humidifiers in accordance with manufacturer's instructions.
- 3.2.4 Line side power wiring shall be provided under Division 26 - Electrical. Provide certified wiring schematics to the Division 26 - Electrical Contractor for associated equipment.
- 3.2.5 Field control wiring of local safeties and interlocks shall be provided as part of the work of this Section.
- 3.2.6 Install Schedule 40 pipe between humidifier outlet and steam distribution pipe(s). Refer to Section 20 07 00 – Mechanical Insulation and Section 23 22 13 - Steam and Condensate Piping for insulation and installation requirements.
- 3.2.7 Provide flue gas venting as per manufacturer's recommendations.
- 3.2.8 Locate steam generator close to and below distribution grids.
- 3.2.9 Connect to natural gas supply piping. Provide isolation valves, pressure regulators and piping specialties as required by local gas code and to suit gas pressure.
- 3.2.10 Provide DN15 ($\frac{1}{2}$ ") type "L" copper water supply piping with shut

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off valve and back flow preventer for steam generators and condensate cooler.

- 3.2.11 Provide drain piping for overflow and drain on condensate cooler, sloped 1 in 25, terminating over floor drain with an air gap.

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Appendix A City of Toronto BAS Standards	

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Equipment	Base Specification Supplier	Alternate Manufacturers	Deduct from Base Tender Price
Access Doors	• Acudor	• Lehage • Zurn • Mifab • Nailor-Hart • Josam • SMS	\$ _____ \$ _____ \$ _____ \$ _____ \$ _____ \$ _____
Fire Stopping	• Firebarrier	• Hilti • Tremco	\$ _____ \$ _____
Hangers	• Taylor	• Grinnell • Anvil • Myatt	\$ _____ \$ _____ \$ _____
Valve, Pipe and Equipment Identification	• SMS	• MagTool • Seton	\$ _____ \$ _____
Motor Control Centres, Starters	• Square D	• Siemens • Cutler-Hammer • Klockner-Moeller • Westinghouse	\$ _____ \$ _____ \$ _____ \$ _____
Variable Frequency Drives	• AC Tech	• Siemens • Hitachi • Danfoss • ABB • Graham	\$ _____ \$ _____ \$ _____ \$ _____ \$ _____
Air Compressors	• Ingersoll-Rand	• Broomwade • Atlas-Copco • DeVilbiss	\$ _____ \$ _____ \$ _____
Thermometers and Gauges	• Terrice	• Taylor • Winters • Ashcroft	\$ _____ \$ _____ \$ _____
Building Automation and Control System	• Alerton	• Siemens • Honeywell • Johnson Controls • Automated Logic • Vykon/Net Elect. • Delta Controls	\$ _____ \$ _____ \$ _____ \$ _____ \$ _____ \$ _____
Automatic Control Dampers	• Ruskin	• Tamco	\$ _____
Automatic Control Valves	• Johnson Controls	• Siemens • Belimo • Honeywell	\$ _____ \$ _____ \$ _____

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Equipment	Base Specification Supplier	Alternate Manufacturers	Deduct from Base Tender Price
Valve and Damper Actuators	• Belimo	• Siemens • Johnson Controls • Honeywell	\$ _____ \$ _____ \$ _____

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements shall apply to and govern this Section.

1.1.2 Appendix A City of Toronto BAS Standards shall apply to and govern this section.

1.1.3 If there is a discrepancy between documents the Appendix A City of Toronto BAS Standards shall govern.

1.2 SCOPE OF WORK

1.2.1 Provide an open protocol Building Automation System (BAS) utilizing Distributed Digital Control (DDC) to serve new mechanical and associated systems as described on the drawings and in this specification. Extend the existing City of Toronto Framework to this new building.

1.2.2 Provide all labour, materials, Products, equipment, and services to supply, install, and commission the electronic control and monitoring system with electronic actuation as specified in Specification Division 25 – Integrated Automation.

1.2.3 Provide all computer hardware and software, operator input/output communication devices, communication units, a communication interface to digital system controllers, field sensors, and controls as required to meet the specified performance.

1.2.4 Provide all labour, including calibration, commissioning, software programming and data base generation, generation of colour graphics and additional work necessary to provide a complete and fully operating system.

1.2.5 Provide all necessary wiring for fully complete and functional control system as specified in the Contract Documents.

1.3 GENERAL SYSTEM REQUIREMENTS

1.3.1 Provide an open protocol BAS with a single architecture common data base microprocessor based electronic control and monitoring BAS system for air handling equipment, heating and cooling and other specified systems employing distributed processing and direct digital control (DDC) with electronic sensing and electronic actuation to conform with the specification requirements. The BAS

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shall consist of the following:

- 1.3.1.1 Stand-Alone DDC Controllers
- 1.3.1.2 Application Specific Controllers (ASC)
- 1.3.1.3 Microcomputer based Advanced Application Controllers (AAC)
- 1.3.1.4 Microcomputer based Building Controllers (BC)
- 1.3.1.5 Smart Actuators (SA)
- 1.3.1.6 Personal computer operator work station (OWS) with colour graphic data displays
- 1.3.2 The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, Application Specific Controllers, and operator devices.
- 1.3.3 The BAS shall be designed and implemented entirely for use and operation on the Internet and the Owner's Intranet. This functionality for operational access shall extend down to the field panel and field point level.
- 1.3.4 The primary Controls Application Nodes (AN) shall be fully IT compatible nodes operating over the industry standard IT infrastructure provided for the Project. The Subcontractor responsible for the work of Division 25 (BAS Contractor) shall coordinate with the IT infrastructure support staff or Subcontractors to ensure compatibility and performance of the operation of the BAS over the LAN/WAN made available for its shared use. If the Owner's LAN/WAN is not made available at time of commissioning, this Division shall supply an independent network cabling system for this Division's communication.
- 1.3.5 The Controls Systems Tier 1 network shall be configured on IT industry standard off-the-shelf technologies compatible with other building systems and Project network arrangements.
- 1.3.6 All aspects of the Controls Systems Operator Interface shall be provided to operate through an IT industry standard Web Browsers such as Internet Explorer, Firefox, Chrome or Opera. The system shall support standard Web browser access via the City's Intranet/Internet.
- 1.3.7 The Web Browser based Operator Interface provided shall

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incorporate complete tool sets, operational information displays, multi-Window displays and other interactive aids to assist interpretation and ease of use. Simple HTML based web page displays are not acceptable.

- 1.3.8 The Web Browser based Operator Interface provided shall not require the procurement or licensing of any special or proprietary software from the BAS Contractor or its suppliers for the Controls Systems OWS. It shall support a minimum of 100 simultaneous users with the ability to access the graphical data and real time values.
- 1.3.9 As required for the functional operation of the Controls Systems, the BAS Contractor shall provide all necessary digital processor programmable Server(s). These Server(s) shall be utilized for Controls Systems Application configuration, for archiving, reporting and trending of data, for Operator transaction archiving and reporting, for network information management, for alarm annunciation, for Operator Interface tasks, for Controls Application management and the like. These Server(s) shall utilize IT industry standard data base platforms such as Microsoft SQL Server and Microsoft Data Engine (MSDE) or approved equal.
- 1.3.10 Provide a fully distributed processing, on-line, real-time, direct digital control Controls Systems Application in compliance with all applicable codes and as approved by the Authorities Having Jurisdiction (AHJ) at the Site. All communication between Controls Application Nodes shall be digital only.
- 1.3.11 All Controls Systems Application facilities and features shall be accessible via Enterprise Intranet and Internet Browser with user ID or Password access control for user access.
- 1.3.12 The Controls Systems Application shall support auto-dial/auto-answer communications to allow Controls Systems Nodes to communicate with other remote Controls Systems Nodes via standard telephone lines. The lines shall be provided by the Owner at the Owner's cost.
- 1.3.13 The Controls Systems Application network shall utilize an open architecture capable of each and all of the following:
 - 1.3.13.1 Utilizing standard Ethernet communications and operate at a minimum speed of 100 Mb/sec.
 - 1.3.13.2 Connecting via BACnet at the Tier 1 level in accordance with

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ANSI/ASHRAE Standard 135-2001.

- 1.3.13.3 Connecting via manufacturer specific Protocol at the Tier 2 level.
(i.e. Johnson Controls N2).
- 1.3.14 Downloading and Uploading
 - 1.3.14.1 Provide the capability to generate and modify the Controls Systems Application software-based sequences, database elements, associated operational definition information, and user-required revisions to same at any designated Workstation together with the means to download same to the associated Controls Systems Application Node.
 - 1.3.14.2 The Controls Systems Application software tool provided for the generation of custom and database definitions shall be resident in both the Controls Systems Application Node and Controls Systems Application Server(s).
 - 1.3.14.3 Provide the capability to upload Controls Systems Application operating software information, database items, sequences, and alarms to designated Server(s).
 - 1.3.14.4 The functions of this Part shall be governed by the codes, approvals, and regulations applying to this Controls Systems Application as provided.
- 1.3.15 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O and data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- 1.3.16 DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller or combination of controllers on the network without dependence upon a central processing device. DDC Controllers shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.
- 1.3.17 Provide English language operator interface using readily understood English language abbreviations and mnemonics.

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- 1.3.18 Future buildings must have the ability to communicate to this building using the BACNet Protocol. The successful Controls Contractor shall provide a PICS (Protocol Implementation Conformance Statement) for the BACNet Gateway. (Minimum conformance of Class 4). The intent is to ensure that existing and future buildings using alternate manufacturers will be able to integrate to this building.
- 1.3.19 Open Protocols by definition are to be BACnet (ASHRAE Standard 135 – Annex J) and Haystack only.
- 1.3.20 BAS Systems Integration:
 - 1.3.20.1 All control systems must be integrated to the City's J2 Innovations Fluid Integration (FIN) server, including but not limited to the following
 - 1.3.20.1.1 Graphical user interface (monitoring & control)
 - 1.3.20.1.2 Alarming
 - 1.3.20.1.3 Data trending
 - 1.3.20.1.4 Data archiving
 - 1.3.20.1.5 Project Haystack naming convention
 - 1.3.20.2 The installer must be licensed by J2 Innovations to sell, install, program and configure Fluid Integration (FIN).
- 1.4 **SYSTEM PERFORMANCE**
 - 1.4.1 The system shall conform to the following:
 - 1.4.1.1 Graphic Display. The system shall be dashboard based, and also capable of displaying a graphic with 20 dynamic points/objects with all current data within 10 seconds.
 - 1.4.1.2 Graphic Refresh. The system shall update a graphic with 20 dynamic points/objects with all current data within 8 seconds.
 - 1.4.1.3 Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds.
 - 1.4.1.4 Object Scan. All changes of state and change of analog values will

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be transmitted over the high-speed Ethernet network such that any data used or displayed at a controller or workstation will have been current within the previous 2 seconds.

- 1.4.1.5 Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.
- 1.4.1.6 Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 1 second. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
- 1.4.1.7 Performance. Programmable controllers shall be able to execute DDC PID control loops at a frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
- 1.4.1.8 Multiple Alarm Annunciation. All workstations on the network must receive alarms within 5 seconds of each other.
- 1.4.1.9 Reporting Accuracy. The system shall report all values with an end-to-end accuracy as listed or better than those listed in the below table.

Measured Variable	Reported Accuracy
Space Temperature	±0.5°C [±1°F]
Ducted Air	±0.5°C [±1°F]
Outside Air	±1.0°C [±2°F]
Dewpoint	±1.5°C [±3°F]
Water Temperature	±0.5°C [±1°F]
Delta-T	±0.15°C [±0.25°F]
Relative Humidity	±5% RH
Water Flow	±5% of full scale
Airflow (terminal)	±10% of full scale (see Note
Airflow (measuring stations)	±5% of full scale
Air Pressure (ducts)	±25 Pa [±0.1 "W.G.]
Air Pressure (space)	±3 Pa [±0.01 "W.G.]
Water Pressure	±2% of full scale (see Note
Electrical (A, V, W, Power factor)	5% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO ₂)	±50 ppm
Note 1: 10%-100% of scale	

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Measured Variable	Reported Accuracy
Note 2: For both absolute and differential	
Note 3: Not including utility-supplied meters	

1.4.1.10 Energy Reporting. The operating software shall have as standard, dashboard widgets which can be selected by the operator to create individual interface points as well as multi-trend graphics as standard.

1.4.1.11 Stability of Control. Control loops shall maintain measured variable at setpoint within the tolerances listed in the below table.

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	± 50 Pa [± 0.2 " w.g.] ± 3 Pa [± 0.01 " w.g.]	0-1.5 kPa [0-6" w.g.] -25 to 25 Pa [-0.1 to 0.1" w.g.]
Airflow	$\pm 10\%$ of full scale	
Temperature	$\pm 0.5^{\circ}\text{C}$ [$\pm 1.0^{\circ}\text{F}$]	
Humidity	$\pm 5\%$ RH	
Fluid Pressure	± 10 kPa [± 1.5 psi]	0-1 kPa [1-150 psi]
Pressure Differential	± 250 Pa [± 1.0 " w.g.]	0-12.5 kPa [0-50" w.g.]

1.5 COMMUNICATION

1.5.1 All control products provided for this project shall comprise a BACnet internetwork. Communication involving control components (i.e., all types of controllers and Operator Workstations) shall conform to ANSI/ASHRAE Standard 135-2004-Annex J, BACnet.

1.5.2 Each BACnet device shall operate on the BACnet Data Link/Physical layer protocol specified for that device as defined in this Section.

1.5.3 The Contractor shall provide all communication media, connectors, repeaters, bridges, hubs, switches, and routers necessary for the

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internetwork.

- 1.5.4 All controllers shall have a communication port for connections with the Operator Workstations using the BACnet Data Link/ Physical layer protocol.
- 1.5.5 Communication services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:
- 1.5.6 Connection of an Operator Workstation device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.
- 1.5.7 All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform internetwork value passing.
- 1.5.8 The time clocks in all applicable controllers shall be automatically synchronized daily. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the network.
- 1.5.9 The network shall have the following minimum capacity for future expansion:
 - 1.5.9.1 Each Building Controller shall have routing capacity for 99 controllers.
 - 1.5.9.2 The Building Controller network shall have capacity for 1000 Building Controllers.
 - 1.5.9.3 The system shall have an overall capacity for 12,500 Building Controller, Advanced Application Controller, and Application Specific Controller input/output objects.

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1.6 QUALITY ASSURANCE

- 1.6.1 All labour, material, equipment and software not specifically referred to herein or on the plans, but are required to meet the functional intent, shall be provided without additional cost to the Owner.
- 1.6.2 Materials and equipment shall be the catalogue products of a single manufacturer regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements. Products referenced under this Section establish the minimum acceptable standards of the Product features, quality, and performance.
- 1.6.3 The BAS Contractors shall be manufacturers or licensed factory representatives and installers of the manufacturers, specified for the local area in which the Site is located.
- 1.6.4 The installing Subcontractor shall have an established working relationship with the Control System Manufacturer.
- 1.6.5 The installing Subcontractor shall have successfully completed Control System Manufacturer's classes on the control system. The installing Subcontractor shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.
- 1.6.6 All products used in this installation shall be new, currently under manufacture, and shall be applied in standard off the shelf products. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner or Consultant in writing. Spare parts shall be available for at least 5 years after completion of this Contract.
- 1.6.7 The BAS Contractor shall have single source responsibility for the complete installation and proper operation of the DDC control system and BAS, including debugging and proper calibration of each component in the entire system.
- 1.6.8 During the initial design the Owner will supply the BAS Contractor a range of BACnet addresses the BAS will run on. The BAS network will run either BACnet over IP or BACnet over MSTP. All BAS points will be network visible so that other BACnet systems can auto discover them. The Contractor shall consult with the Owner during the development of addresses.

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- 1.6.9 The BAS shall be compatible with future control Products for 10 years or more.
- 1.6.10 Include all software, associated licensing, upgrades, and labour/materials for two (2) years from the date of the Total Performance of the Work.
- 1.6.11 Provide satisfactory operation without damage at 110% above and 85% below rated voltage and at 3 hertz variation in line frequency. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be AC coupled, or equivalent so that any single device failure will not disrupt or halt bus communication.
- 1.7 REFERENCE STANDARDS
 - 1.7.1 All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, provincial, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and Specifications.
 - 1.7.1.1 Ontario Building Code
 - 1.7.1.2 Ontario Electrical Code
 - 1.7.1.3 ANSI/ASHRAE 135-2004
 - 1.7.1.4 NFPA 90A & 90B
 - 1.7.2 Provide electrical and electronic equipment which is CSA approved where such approval is required by the regulatory authorities.
 - 1.7.3 Provide ASCII American Standard for Communication and Information Interchange code input/output devices with standard EIA Electronic Industry Association interface.
 - 1.7.4 All devices shall be ULC, UL or FM Listed and labeled for the specific use, application and environment to which they are applied.
- 1.8 SUBMITTALS
 - 1.8.1 The Contractor shall provide shop drawings or other submittals on all hardware, software, and installation to be provided. No work may begin on any segment of this project until submittals have

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been reviewed and approved for conformity with the design intent. All drawings shall be done in DXF or pdf format and provided on magnetic/optical disk and as full-size drawings. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Submittals shall include:

- 1.8.1.1 A complete bill of materials of equipment to be used shall be listed indicating quantity, manufacturer, model number, and other relevant technical data.
- 1.8.1.2 Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for each system component.
- 1.8.1.3 Wiring diagrams and layouts for each control panel. Show all termination numbers.
- 1.8.1.4 A schematic diagram for all control wiring, communication wiring and power wiring shall be provided. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers, function and data link protocol(s). Show all interface wiring to the control system.
- 1.8.1.5 Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware on the BAS graphics as it relates to the equipment being controlled.
- 1.8.1.6 Provide detailed riser diagrams of wiring between central control unit, operator workstation(s), routers, gateways and all control panels.
- 1.8.1.7 Examples of the color graphic dashboard screens shall be provided. Provide 3 screen shots from 5 existing projects representing various systems. For each screen, provide a conceptual layout of pictures and data, and show or explain which other screens can be directly accessed.
- 1.8.1.8 A schematic diagram of each controlled system. The schematics shall have all control points/objects labeled and with point/object names shown or listed. The schematics shall graphically show the location of all control elements in the system.

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- 1.8.1.9 A complete control points list.
- 1.8.1.10 An instrumentation list for each controlled system. Each element of the controlled system shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.
- 1.8.1.11 A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
- 1.8.1.12 A point/object list for each system controller including inputs and outputs (I/O), point/object number, the controlled device associated with the I/O point/object, and the location of the I/O device. Software flag points/objects, alarm points/objects, etc.
- 1.8.1.13 A BACnet Protocol Implementation Conformance Statement (PICS) for each type of controller and Operator Workstation included in the submittal. PICS shall include for each Product, as a minimum, a list of BACnet functional groups supported, BACnet services supported, BACnet data link options available and BACnet objects provided.
- 1.8.1.14 Point-to-point verification check sheets once completed.
- 1.8.2 Upon completion of the Work, provide a complete set of 'as-built' drawings, application software and layout colour graphics on compact disc. Drawings shall be provided as AutoCAD™ compatible files. Two complete sets of hard copies are also to be provided to the Owner.
- 1.9 **OWNERSHIP OF PROPRIETARY MATERIAL**
- 1.9.1 All project-developed software and documentation shall become the property of the Owner. These include, but are not limited to:
 - 1.9.1.1 Project graphic images
 - 1.9.1.2 Record drawings
 - 1.9.1.3 Project database
 - 1.9.1.4 Project-specific application programming code
 - 1.9.1.5 All documentation
- 1.10 **LICENSING REQUIREMENTS**

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- 1.10.1 License shall be provided to and in the name of the City of Toronto.
- 1.10.2 Licenses shall be perpetual, transferrable, assignable and royalty-free.
- 1.10.3 Tridium licenses shall allow all Workbench/Supervisor brands complete system access and Functionality.

1.11 INSTALLER AND MANUFACTURER QUALIFICATIONS

- 1.11.1 Installer shall have an established working relationship with Control System Manufacturer.
- 1.11.2 Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.
- 1.11.3 System shall be an open protocol state-of-the-art distributed computerized Building Management and Control System which is user friendly, has known reliability, is extremely responsive, and which is to be designed, installed and implemented and supported by a local office of approved bidders.
- 1.11.4 BAS contractor shall provide three locations of successful installations of similar open protocol computer based systems. Sites provided must consist of more than 150 hardware inputs/outputs. Project sites must be local to the location of this project.

1.12 SYSTEM ADMINISTRATION

- 1.12.1 Administrator credentials shall be sent to BAS@Toronto.ca for retention by the City. Credentials shall include any and all accounts and passwords required for complete system access including but not limited to Station and Platform credentials.

2 **PRODUCTS**

2.1 VENDORS

- 2.1.1 Any vendors that are authorized dealers or distributors of the following control systems are acceptable:
 - 2.1.1.1 Delta Controls
 - 2.1.1.2 Reliable Controls

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2.1.1.3 Schneider Electric SmartX series

2.1.1.4 Distech Controls

2.1.1.5 Johnson Controls Facility Explorer

2.1.1.6 Honeywell CIPer series, Spyder models 5 or 7

2.2 BAS SYSTEM INTEGRATION

2.2.1 Building Controllers (BC) must be Tridium Niagara JACE with Haystack module and driver. The installer must be a licensed Tridium system integrator for any Tridium BCs or embedded or edge Niagara Framework products used. Soft JACE is not accepted.

3 **EXECUTION**

3.1 BAS DEMONSTRATION

3.1.1 All BAS Demonstration shall take place on the main Control Systems Server and WAN. Schedule to add system to main Control Systems Server and WAN with Owner at least two (2) weeks in advance to the demonstration. At the time of request, provide all documentation that the following criterions are met:

3.1.1.1 Updated BAS submittals in electronic and hard copy to the Owner including the updated riser diagram for the system.

3.1.1.2 Reports on verification of Network Layout Verification including but not limited to Building Controller locations, cable routes with length of cable between controllers and any trunk extenders or trunk isolators.

3.1.1.3 Reports on verification of electrical characteristics of BAS network, communications and electrical integrity of Building Controllers.

3.1.1.4 Reports on verification of traffic on BAS Network including but not limited to COVs between Building Controllers, point commands by the operator, point commands by program across the network, alarm reporting on the network, any unresolved points in the system, integrity of the ports on any Building Controller isolator/extender and results of Building Controller tests running at selected baud rate.

3.1.1.5 Demonstrate to the Owner the updates of databases without errors or faults between the temporary Control Systems Server and

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Building Controllers. If there is no temporary server, demonstrate to Owner after system is added to main Control Systems Server.

- 3.1.1.6 Reports on verification of system log files, interruption of log files of system traffic and overall acceptable operation of the system where a temporary Control Systems Server is utilized.
- 3.1.2 Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the Owner. Schedule the demonstration with the Owner seven (7) calendar days in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved. If the Work fails to conform to the Contract Documents, and additional Site visits by the Owner are to be scheduled for re-demonstration, the Contractor shall reimburse the Owner for costs of subsequent Site visits.
- 3.1.3 The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to instruments, ladders, etc. The Contractor-supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the Site.
- 3.1.4 Demonstration shall typically involve small representative samples of systems/equipment randomly selected by the Owner.
- 3.1.5 The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved checklists. Demonstration shall include, but not necessarily be limited to, the following:
 - 3.1.5.1 Demonstrate that required software is installed on BAS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.
 - 3.1.5.2 Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified in the Contract Documents.
 - 3.1.5.3 Demonstrate that remote dial-up communication abilities are in accordance with these Specifications.
 - 3.1.5.4 Demonstrate correct calibration of input/output devices using the same methods specified for the Start-Up Tests. A maximum of 10 percent of I/O points shall be selected at random by the Owner for

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demonstration. Upon failure of any device to meet the specified end-to-end accuracy, an additional 10 percent of I/O points shall be selected at random by the Owner for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified end-to-end accuracy.

- 3.1.5.5 Demonstrate that all DDC and other software programs exist at respective field panels. The Direct Digital Control (DDC) programming and point database shall be as submitted and approved.
- 3.1.5.6 Demonstrate that all DDC programs accomplish the specified sequence of operation.
- 3.1.5.7 Demonstrate that the panels and DDC network of panels automatically recover from power failures within five (5) minutes after power is restored.
- 3.1.5.8 Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels' response to LAN communication failures meets the requirements of these Specifications.
- 3.1.5.9 Identify access to equipment selected by the Owner. Demonstrate that access is sufficient to perform required maintenance.
- 3.1.5.10 Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.
- 3.1.6 BAS Demonstration shall be completed and approved prior to the Substantial Performance of the Work.
- 3.1.7 Any tests successfully completed during the demonstration will be recorded as passed for the functional performance testing and will not have to be retested.
- 3.2 **BAS ACCEPTANCE PERIOD**
- 3.2.1 After approval of the BAS Demonstration and prior to Total Performance of the Work, Acceptance Period shall commence. Acceptance Period shall not be scheduled until all HVAC systems are in operation and have been accepted, all required cleaning and lubrication has been completed (i.e., filters changed, piping flushed, strainers cleaned, and the like), and TAB report has been submitted and approved. Acceptance Period and its approval will

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be performed on a system-by-system basis if mutually agreed upon by the Contractor and the Owner.

3.2.2 Operational Test: At the beginning of the Acceptance Period, the system shall operate properly for set period as agreed with the Owner without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these Specifications. At the end of this period, the Contractor shall forward the trend logs to the Owner for review. The Owner shall determine if the system is ready for functional performance testing and document any problems requiring the Contractor's attention.

3.2.2.1 If the systems are not ready for functional performance testing, the Contractor shall correct problems and provide notification to the Owner that all problems have been corrected. The Acceptance Period shall be restarted at a mutually scheduled time for an additional period.

3.2.2.2 This process shall be repeated until Owner issues notice that the BAS is ready for functional performance testing.

3.2.3 During the Acceptance Period, the Contractor shall maintain a hard copy log of all alarms generated by the BAS. For each alarm received, the Contractor shall diagnose the cause of the alarm, and shall list on the log for each alarm, the diagnosed cause of the alarm, and the corrective action taken. If in the Contractor's opinion, the cause of the alarm is not the responsibility of the Contractor, the Contractor shall immediately notify the Owner.

3.2.4 Once 5 consecutive days of alarm-free operation are complete and documented, operator training may begin.

3.3 TRAINING

3.3.1 Upon completion of the work and prior to the Substantial Performance of the Work, the Owner's operating and maintenance personnel shall be given complete instructions on the operation and maintenance of the complete system. Include a description of the information flow from field sensors, contacts and devices to the ASCs. Give an overview of the system's communication network to provide a better understanding to the operator of the interplay between initiating devices, field hardware panels, system communications, and their importance within the operating BAS.

3.3.2 An Owner's manual prepared for this project by BAS Contractor

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shall be used in conjunction with the training. Two copies of the Owner's manual shall be provided.

3.3.3 During system commissioning and at such time as acceptable performance of the BAS hardware and software has been established, the BAS Contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall take place during normal working hours and shall be performed by a competent representative of the BAS Contractor, familiar with the BAS software, hardware, and accessories.

3.3.4 The Subcontractor responsible for the work of Division 25 shall give 30 hours of instruction to the Owner's designated personnel on the operation of all equipment within the central equipment center and describe its intended use with respect to the programmed functions specified. Operator orientation of the BAS shall include, but not be limited to, the overall operational program, equipment functions (both individually and as part of the total integrated system), commands, system generation, advisories, and appropriate operator intervention required in responding to the system's operation.

3.4 WARRANTY

3.4.1 Labor and materials for the control system specified shall be warranted free from defects for a period of 12 months after final completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner. The Contractor shall respond to the Owner's request for warranty service within 24 hours during normal business hours.

3.4.2 All work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period.

3.4.3 At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the Owner, the Owner will sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of acceptance shall be the start of warranty.

3.4.4 Operator workstation software, project-specific software, graphic

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software, database software, and firmware updates which resolve known software deficiencies as identified by the Contractor shall be provided at no charge during the warranty period. Any upgrades or functional enhancements associated with the above mentioned items also can be provided during the warranty period for an additional charge to the Owner by purchasing an in-warranty technical support agreement from the Contractor. Written authorization by the Owner must, however, be granted prior to the installation of any of the above-mentioned items.

3.4.5 The control contractor shall have in place the capability to monitor the operation of the system on a 24-hour basis.

3.4.6 Parts, which have a wear-out characteristic, such as printer ink cartridges, etc., shall not be counted as failures within the terms of this warranty, if they fail or become worn out beyond their stated life expectancy.

3.5 WARRANTY PHASE BAS OPPOSITE SEASON TRENDING AND TESTING

3.5.1 Throughout the warranty phase, trend logs shall be maintained. The Contractor shall forward archive trend logs to the Owner for review upon the Owner's request. The Owner will review these and notify the Contractor of any warranty work required.

3.5.2 Within twelve (12) months of the Substantial Performance of the Work, the Contractor shall schedule and conduct with the Owner an opposite season functional performance testing. The BAS Contractor shall participate in this testing and remedy any deficiencies identified.

3.6 BAS COMMISSIONING

3.6.1 Refer to Section 20 08 00 - Commissioning.

3.7 CONTROL STRATEGIES

3.7.1 Refer to Section 25 90 00 – Sequences of Operation for control sequences and to the associated control schematics on the Drawings for the required number of control loops. Provide all hardware and software necessary to achieve specified control. The sequence of events required for each control loop is described for each system in the control sequence.

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END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Sections 20 00 00 and 25 00 00 – General Requirements shall apply to and govern this Section.

1.1.2 Conform to the requirements of Section 26 00 00 - General Electrical Requirements.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Wiring.

1.2.1.2 Control Valves and Actuators.

1.2.1.3 Control Dampers and Actuators.

1.2.1.4 Control Panels.

1.2.1.5 Sensors.

1.2.1.6 Electric Control Components (Switches, EP Valves, Thermostats, Relays, etc.).

1.2.1.7 Transducers.

1.2.1.8 Current Switches.

1.2.1.9 Nameplates.

1.2.1.10 Testing Equipment.

1.2.2 Provide the following electrical work as part of the work of this Section, complying with requirements of Division 26 – Electrical and the requirements of this Section.

1.2.2.1 Control wiring between field-installed controls, indicating devices, and unit control panels in this Section, and as specified in other Sections of this Division and under Divisions 20, 21, 22 and 23.

1.2.2.2 Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated

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for all mechanical and controls.

- 1.2.2.3 Wiring associated with annunciator and alarm panels (remote alarm panels) and connections to their associated field devices.
- 1.2.2.4 Power wiring to field panels and other devices requiring a main supply from circuit breakers provided by Division 26 – Electrical in local emergency power and emergency lighting panels.
- 1.2.2.5 All other necessary wiring for fully complete and functional control system as specified in the Contract Documents.

1.3 ELECTRICAL WIRING

- 1.3.1 All wiring shall be in accordance with the latest edition of the Ontario Electrical Safety Code and Division 26 - Electrical. This includes wiring between control components and wiring from such components to electrical circuits of fans, pumps, and any other equipment.
- 1.3.2 Electrical interlock wiring of field devices (i.e., flow switches, thermostats) associated with equipment specified under other Sections of Division 25 and under Divisions 21, 22 and 23 is the responsibility of this Section, unless indicated otherwise in the Contract Documents.

1.4 CO-ORDINATION OF WORKS

- 1.4.1 The BAS Contractor shall design, provide, install, test, commission, and guarantee the system.
- 1.4.2 Provide all control devices, instrumentation, relays, auxiliary contacts, and transformers as specified in the Contract Documents and as required to meet the control and monitoring points and sequence of operation.
- 1.4.3 Extend control wiring requiring interfacing to systems by Division 26 – Electrical (i.e. fire alarm system, diesel generator control panel, etc.) to respective panel for termination by Division 26 - Electrical.
- 1.4.4 Dampers
 - 1.4.4.1 Manual balancing dampers, fire dampers, combination fire/smoke dampers and back draft dampers are provided as part of the work of their respective Divisions.

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- 1.4.5 Smoke dampers shall be supplied as part of the work of this Division and installed under Division 23 - HVAC. The BAS Contractor shall provide and connect all associated damper actuators and damper position sensor devices.
- 1.4.5.1 The BAS Contractor shall supply all remaining automatic control dampers not integral part of equipment specified elsewhere in Division 23. These dampers are to be installed as part of the work of Division 23 – HVAC under the direction of the BAS Contractor who will be fully responsible for the proper operation of the dampers. The BAS Contractor shall provide and connect all associated damper actuators.
- 1.4.5.2 The BAS Contractor shall provide and connect all damper actuators for dampers specified as an integral part of equipment specified elsewhere in the Contract Documents.
- 1.4.6 Automatic Control Valves
- 1.4.6.1 The BAS Contractor shall supply all automatic control valves required by the sequences of operation and not integral part of equipment specified elsewhere in Divisions 22 and 23. These valves are to be installed as part of the work of Division 22 – Plumbing and Division 23 – HVAC, under the direction of the BAS Contractor who will be fully responsible for the proper operation of the valves. The BAS Contractor shall provide and connect all associated valve actuators.
- 1.4.7 Work by other sections
- 1.4.7.1 The following equipment is supplied by the BAS Contractor, installed under Division 22 and 23, and connected by the BAS Contractor.
- 1.4.7.1.1 Air flow measuring stations
- 1.4.7.1.2 Water pressure sensors
- 1.4.7.1.3 Water pressure taps, thermal wells, flow switches, flow meters, etc. that will have wet surfaces, shall be installed under the applicable piping Section under the direction of the BAS Contractor who will be fully responsible for the proper installation and application.
- 1.4.7.2 Division 26 - Electrical shall provide:
- 1.4.7.2.1 120-volt AC 15 amp dedicated emergency power circuits for power

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to the Building Automation System, including all mechanical rooms and control panels.

1.4.7.2.2 Termination at fire alarm system, diesel generator control panel, etc.

1.4.7.3 All other installation work required for the complete installation of the Building Automation System shall be provided by the BAS Contractor.

1.4.7.4 The BAS Contractor shall co-ordinate the control work involving Divisions 20, 21, 22, 23 and 26 - Electrical.

1.5 SUBMITTALS

1.5.1 Provide shop drawings for:

1.5.1.1 Control Valves and Actuators.

1.5.1.2 Control Dampers and Actuators.

1.5.1.3 Control Panels.

1.5.1.4 Sensors.

1.5.1.5 Electric Control Components (Switches, EP Valves, Thermostats, Relays, etc.).

1.5.1.6 Transducers.

1.5.1.7 Current Switches.

1.5.1.8 Testing Equipment.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All materials shall meet or exceed all applicable referenced standards, and conform to codes and ordinances of authorities having jurisdiction.

2.1.2 Provide electronic, pneumatic, and electric control products in sizes and capacities indicated, consisting of valves, dampers, controllers, sensors, and other components as required for complete installation. Except as otherwise indicated in the Contract Documents, provide manufacturer's standard materials

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and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

2.2 INSTRUMENT PIPE AND TUBE

2.2.1 Hydronic and instruments:

2.2.1.1 Connection to main piping: Provide 15mm (½ inch) minimum size threadolet, 15mm x 50mm (½ inch x 2 inch) brass nipple, and 15mm (½ inch) ball valve for connection to welded steel piping. Provide tee fitting for other types of piping.

2.2.1.2 Remote instruments: Adapt from ball valve to specified tubing and extend to remote instruments. Provide a union or otherwise removable fitting at ball valve so that connection to main can be cleaned with straight rod. Where manifolds with test ports are not provided for instrument, provide tees with 6mm (¼ inch) FPT branch with plug for use as test port. Adapt from tubing size to instrument connection.

2.2.1.3 Line mounted instruments: Extend rigid piping from ball valve to instrument. Do not use close or running thread nipples. Adapt from ball valve outlet to instrument connection size. Provide a plugged tee if pipe makes 90 degree bend at outlet of valve to allow cleaning of connection to main with straight rod without removing instrument.

2.2.1.4 Instrument tubing: Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; or brass compression-type fittings. Solder shall be 95/5 tin antimony, or other suitable lead free composition solder. Tubing outside diameter size shall be not less than the larger of 6mm (¼ inch) or the instrument connection size.

2.2.1.5 Rigid piping for line mounted instruments: Schedule 40 threaded brass, with threaded brass fittings.

2.2.2 Low pressure air instrument sensing lines:

2.2.2.1 Connections: Use suitable bulkhead type fitting and static sensing tip for static pressure connections. Adapt tubing to instrument connection.

2.2.2.2 Tubing: Virgin polyethylene non-metallic tubing type FR, ASTM D

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2737, with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.

2.3 WIRING

2.3.1 Communication Wiring:

2.3.1.1 Communication wiring shall be provided in a customized color jacketing material. Material color shall be as submitted and approved by the Owner. In addition, all wiring jackets shall be labeled "BAS" in three (3) foot or fewer intervals along the length of the jacket material. An example is provided below:

Purpose	Function	Color	Label
Building Level	Communication	Orange	BAS Building Level Communication
Floor level	Communication	Blue	BAS Floor Level Communication
Inputs/Outputs	Panel to device	White	BAS Input Output Device Cable
24VAC	Control power	White/Black tracer	BAS 24 VAC Control Power

2.3.1.2 The BAS Contractor shall supply all communication wiring between Building Controllers, Routers, Gateways, AAC's, ASC's and local and remote peripherals (e.g., operator workstations, printers, and modems).

2.3.1.3 Local Supervisory LAN: For any portions of this network required under this Section of the Specification, the BAS Contractor shall use multimode fiber (62.5 micron) or Category 5E cable per TIA/EIA 68 (10BaseT). Network shall be run with no splices and separate from any wiring over 30V.

2.3.1.4 Primary and Secondary Controller LANs: Communication wiring shall be individually 100% shielded pairs per manufacturer's recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over 30V. Shield shall be terminated and wiring shall be grounded as recommended by building controller manufacturer.

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2.3.2 Signal Wiring:

2.3.2.1 Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gage wire, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above 30V.

2.3.2.2 Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

2.3.3 Low Voltage Analog Output Wiring:

2.3.3.1 Low voltage control wiring shall be minimum 18-gage, twisted pair, 100% shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above 30V.

2.3.4 Control Panels:

2.3.4.1 Provide control panels with suitable brackets for wall mounting, unless noted otherwise, for each control system. Locate panel adjacent to systems served. Mount center of control panels 1,524mm (60 inches) above finished floor or roof.

2.3.4.2 Interior mount: Fabricate panels of 0.0625mm (16-gauge) furniture-grade steel, totally enclosed on four sides, with removable perforated backplane, hinged door and keyed lock, with manufacturer's standard shop-painted finish and color.

2.3.4.3 Exterior mount: 0.0625mm (16-gauge) 304 or 316 stainless steel NEMA 4X enclosure. Panel shall have hinged door, keyed lock, and integral, thermostatically controlled heater. Provide hinged deadfront inside panel when flush-mounted control and/or indicating devices are included in panel. Fiberglass or aluminum, as applicable, to be used when gases that are being used in the panel area are corrosive to stainless steel.

2.3.4.4 Provide UL-listed cabinets for use with line voltage devices.

2.3.4.5 Control panel shall be completely factory wired and piped, and all electrical connections made to a terminal strip.

2.3.4.6 All gauges and control components shall be identified by means of nameplates.

2.3.4.7 All control tubing and wiring shall be run neatly and orderly in open

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slot wiring duct with cover.

2.3.4.8 Provide a 150mm x 150mm (6" x 6") minimum wireway (metal wiring/tubing) trough across the entire width of the panel mounted to the top of the panel with close nipples of sufficient size for additional 50% wiring and tubing capacity. Wireways shall not be less than 610mm (24") in length. Control panel wiring shall be installed and distributed in the wireway to minimize routing of wiring and tubing within the control panel. Wireway construction to be the same as the associated control panel.

2.3.4.9 Complete wiring and tubing termination drawings shall be mounted in, and a second set mounted adjacent to, each panel in a frame with Lexan cover of sufficient size to be easily readable.

2.4 AUTOMATIC CONTROL DAMPERS

2.4.1 Provide factory fabricated automatic control dampers of sizes, velocity and pressure classes as required for smooth, stable, and controllable airflow. For dampers located near fan outlets, provide dampers rated for fan outlet velocity and close-off pressure, and recommended by damper manufacturer for fan discharge damper service. Control dampers used for smoke dampers shall comply with UL 555S. Control dampers used for fire dampers shall comply with UL 555.

2.4.2 Supply control dampers with a leakage rate of less than 15 L/s / m² (3 cfm/sq. ft.) at 249 Pa (1" w.g.) static pressure difference.

2.4.3 Use opposed blade type dampers for modulating service. Dampers for two position service, face and bypass and mixing may be parallel blade type.

2.4.4 Construct aluminum airfoil blades of minimum 2.0mm (12-gauge) extruded aluminum. Blades to be 150mm (6") wide single air foil design.

2.4.5 Construct damper frames of extruded aluminum channel with grooved inserts for vinyl seals. Standard frames are 50mm x 100mm x 15mm (2" x 4" x 5/8") on linkage side, and 25mm x 100mm x 25mm (1" x 4" x 1") on the other sides.

2.4.6 Provide 22mm (7/8") hexagon extruded aluminum pivot rods that interlock into the blade section. Bearings to be double sealed type with a Celcon inner bearing on a rod within a Polycarbonate outer bearing inserted into frame so that the outer bearing cannot rotate.

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- 2.4.7 Design the bearing to prevent metal-to-metal or metal-to-bearing riding surfaces. Interconnecting linkage shall have a separate Celcon bearing to eliminate friction in linkage.
- 2.4.8 Blade linkage hardware is to be installed in a frame out of the air stream. All hardware to be made of non-corrosive reinforced material or cadmium plated steel.
- 2.4.9 Supply overlapping damper seals that minimize air leakage.
- 2.4.10 Insulate all dampers in direct contact with outside air with 22mm (7/8") thick polyurethane foam. Blade construction must provide a 100% thermal break. Insulate frame with polystyrene.
- 2.4.11 Maximum allowable damper blade length is 1016mm (40") per section.
- 2.4.12 Provide dampers greater than two sections wide with a jackshaft.
- 2.4.13 Acceptable dampers are: T. A. MORRISON (TAMCO) 1000 / 9000 and RUSKIN CD-50 / CD-2000.
- 2.5 **STANDARD SERVICE CONTROL VALVES**
- 2.5.1 Control valve sizing and selection is the responsibility of the BAS Contractor. Provide a valve schedule that lists the requirements of the valves for Cv, close off, temperature, etc. This should be a result of analyzing the valves performance across the range of control.
- 2.5.2 Valves to be factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated in the Contract Documents.
- 2.5.3 Control valves shall be equipped with heavy-duty actuators, selected to proper close-off rating for each individual application.
- 2.5.4 Minimum close-off rating shall be considered at dead head rating of the pump.
- 2.5.5 The control valve assembly shall be provided and delivered from a single manufacturer as a complete assembly.
- 2.5.6 Characterized Control Valves
- 2.5.6.1 50mm (2") and smaller: nickel-plated forged brass body rated at

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2,758 kPa (400 psi), stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc. 20mm ($\frac{3}{4}$ ") and smaller for terminal units: nickel plated forged brass body rated at 4,137 kPa (600 psi), chrome plated brass ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-Ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.

2.5.6.2 65mm (2-1/2") through 80mm (3"): GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring package design, PTFE seats, and a stainless steel flow characterizing disc.

2.5.7 Plug-Type Globe Pattern for Water Service:

2.5.7.1 Where not specifically indicated in the Contract Documents, modulating valves shall be sized for maximum full flow pressure drop between 50% and 100% of the branch circuit it is controlling unless scheduled otherwise. Two-position valves shall be same size as connecting piping or size using a pressure differential of 6.9 kPa (1 psi).

2.5.7.2 Single Seated (Two-way) Valves: Valves shall have equal-percentage characteristic for typical heat exchanger service and linear characteristic for building loop connections unless otherwise scheduled on the drawings. Valves shall have cage-type trim, providing seating and guiding surfaces for plug on 'top-and-bottom' guided plugs.

2.5.7.3 Double Seated (Three-way) Valves: Valves shall have linear characteristic. Valves shall be balanced-plug type, with cage-type trim providing seating and guiding surfaces on 'top-and-bottom' guided plugs.

2.5.7.4 Two- and Three-Way Modulating: twice the load pressure drop, but not more than 34.5 kPa (5 psig).

2.5.7.5 50mm (2") and smaller: ANSI Class 250 bronze body, stainless steel stem, brass plug, bronze seat, and a TFE packing.

2.5.7.6 65mm (2-1/2") and larger: ANSI Class 125 or 250 as applicable, cast iron body, stainless steel stem, bronze plug, bronze seat, and a TFE V-ring packing.

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- 2.5.7.7 Two- and three-way globe valves shall be used only if characterized control valves do not fit the sizing criteria or application.
- 2.5.8 Plug-Type Globe Pattern for Steam Service:
 - 2.5.8.1 Two-Position: line size or sized using 10% of inlet gauge pressure.
 - 2.5.8.2 Modulating: 103 kPa (15 psig) or less: inlet steam pressure, the pressure drop shall be 80% of inlet gauge pressure. Higher than 103 kPa (15 psig) inlet steam pressure: the pressure drop shall be 42% of the inlet absolute pressure.
 - 2.5.8.3 Characteristics: Modified equal-percentage characteristics. Cage-type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
 - 2.5.8.4 50mm (2") and smaller: ANSI Class 250 bronze body; stainless steel seat, stem and plug; and a TFE packing.
 - 2.5.8.5 65mm (2-1/2") and larger: ANSI Class 125 or 250 as applicable, cast iron body, stainless steel seat, stem and plug, and a TFE V-ring packing.
- 2.5.9 Ball Type:
 - 2.5.9.1 Brass or bronze body; one-, two-, or three-piece design; threaded ends; reinforced Teflon seat; stainless steel ball; standard or 'V' style port; stainless steel stem, blow-out proof design, extended to match thickness of insulation.
 - 2.5.9.2 Rating: Cold service pressure 4,138 kPa (600 psi) WOG; Steam working pressure 1,034 kPa (150 psi).
- 2.5.10 Segmented or Characterized Ball Type:
 - 2.5.10.1 Carbon steel (ASTM 216) body, one-piece design with wafer style ends; reinforced teflon (PTFE) seat; stainless steel ASTM A351 ball; segmented design port with equal-percentage characteristic; stainless steel stem.
 - 2.5.10.2 Rating: Cold service pressure 1,380 kPa (200 psi) WOG
- 2.5.11 Pressure Independent Control Valves
 - 2.5.11.1 50mm (2") dia and smaller: forged brass body rated at no less than 2,758 kPa (400 psi), chrome plated brass ball and stem, female

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NPT union ends, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc.

- 2.5.11.2 65mm (2-1/2") through 150mm (6') dia: GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.
- 2.5.11.3 Accuracy: The control valves shall accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 34.5 kPa (5 psi) to 345 kPa (50 psi) differential across the valve with a valve body accuracy of +/- 5% variance due to differential pressure fluctuation or +/- 10% total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.
- 2.5.11.4 Flow Characteristics: Equal percentage characteristics.
- 2.5.11.5 All actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable. Actuators for 3-wire floating (tri-state) and for two-position 15mm (1/2") to 25mm (1") pressure independent control valves shall fail in place and have a mechanical device inserted between the valve and the actuator for the adjustment of flow.
- 2.5.11.6 Coil optimization 65mm (2-1/2") through 150mm (6") shall be accomplished by utilizing a pressure independent control valve assembly; two temperature sensors providing feedback of coil inlet water temperature and coil outlet water temperature; and a flow meter to provide analog flow feedback. Software shall control the valve to avoid the coil differential temperature from falling below a programmed setpoint. Independent trend logs data shall be available by means of BACnet MS/TP trending data to include, but not be limited, to inlet and outlet coil water temperatures, valve position, absolute flow, absolute valve position, absolute power and heating/cooling energy in BTU/hr.
- 2.5.11.7 The BAS Contractor shall ensure that the manufacturer provides a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) and the Testing Adjusting Balancing Bureau (TABB).
- 2.5.11.8 The control valve shall require no maintenance and shall not

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include replaceable cartridges.

- 2.5.12 Butterfly valves may be provided for two-position service. Where indicated on the Drawings, supply motorized butterfly valves complete with pipe tee of same rating as piping specification. Supply tight shut-off valves equipped with a limit switch for position indication.
- 2.5.12.1 50mm (2") to 300mm (12"): valve body shall be full lugged cast iron 1,379 kPa (200 psig) body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize an internal spline. The shaft shall be supported at four locations by RPTFE bushings.
- 2.5.12.2 350mm (14") and larger: valve body shall be full lugged cast iron 1,034 kPa (150 psig) body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize a dual-pin method to prevent the disc from settling onto the liner. The shaft shall be supported at four locations by RPTFE bushings.
- 2.5.12.3 Butterfly valves for medium pressure service: valve body shall be full lugged carbon steel ANSI Class 300 body with a 316 stainless steel disc without a nylon coating, RTFE seat, and be ANSI Class 300 flange standards. Blowout-proof shaft shall be 17-4ph stainless steel and shall be supported at four locations by glass-backed TFE bushings. Valve packing shall be Chevron TFE and shall include fully adjustable packing flange and separable packing gland. Valve body shall have long stem design to allow for 50mm (2") insulation (minimum). Valve face-to-face dimensions shall comply with API 609 and MSS-SP-68. Valve assembly shall be completely assembled and tested, ready for installation.
- 2.5.13 The BAS Contractor shall ensure that the manufacturer warrants all components for a period of 5 years from the date of production, with the first two years unconditional.
- 2.5.14 Cavitation Trim:
- 2.5.14.1 Provide cavitation trim where indicated and/or required, designed to eliminate cavitation and noise while maintaining an equal percentage characteristic. Trim shall be a series of plates with orifices to break the pressure drop into multi-stages.

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2.6 CRITICAL SERVICE CONTROL VALVES

2.6.1 Control valve sizing and selection is the responsibility of the BAS Contractor. Provide a valve schedule that lists the requirements of the valves for Cv, close off, temperature, etc. This should be a result of analyzing the valves performance across the range of control.

2.6.2 General:

2.6.2.1 Provide selection of valve type or body material as determined by installation requirements and pressure class, based on maximum pressure and temperature in piping system.

2.6.2.2 Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve.

2.6.2.3 Control valves shall be equipped with heavy-duty actuators and pilot positioners with proper close-off rating and capability for each individual application.

2.6.2.4 Minimum close-off rating shall be as scheduled and adequate for each application, and shall generally be considered at dead head rating of the pump.

2.7 ENERGY VALVES

2.7.1 Pressure Independent Control Valves with flow and temperature measurements. Based on Belimo.

2.7.1.1 50mm (2") dia and smaller: forged brass body rated at no less than 2,758 kPa (400 psi), chrome plated brass ball and stem, female NPT union ends, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc.

2.7.1.2 65mm (2-1/2") through 150mm (6') dia: GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.

2.7.1.3 Accuracy: The control valves shall accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 34.5 kPa (5 psi) to 345 kPa (50 psi) differential across the valve with a valve body accuracy of +/- 5% variance due to differential pressure fluctuation or +/- 10% total assembly error

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incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.

- 2.7.1.4 Flow Characteristics: Equal percentage characteristics.
- 2.7.1.5 All actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable. Actuators for 3-wire floating (tri-state) and for two-position 15mm (1/2") to 150mm (6") pressure independent control valves shall fail in place and have a mechanical device inserted between the valve and the actuator for the adjustment of flow.
- 2.7.1.6 Coil optimization 15mm (1/2") through 150mm (6") shall be accomplished by utilizing a pressure independent control valve assembly; two temperature sensors providing feedback of coil inlet water temperature and coil outlet water temperature; and a flow meter to provide analog flow feedback.
- 2.7.1.7 Software shall control the valve to avoid the coil differential temperature from falling below a programmed setpoint. Independent trend logs data shall be available by means of BACnet MS/TP trending data to include, but not be limited, to inlet and outlet coil water temperatures, valve position, absolute flow, absolute valve position, absolute power and heating/cooling energy in BTU/hr.
- 2.7.1.8 The BAS Contractor shall ensure that the manufacturer provides a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) and the Testing Adjusting Balancing Bureau (TABB).
- 2.7.2 The control valve shall require no maintenance and shall not include replaceable cartridges.
- 2.8 VALVE AND DAMPER ACTUATORS
- 2.8.1 Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.
- 2.8.2 Provide electric actuators of the enclosed reversible gear drive type that can accept modulating control signals as required.

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Actuators using balance relays or mechanical travel limiting switches are not acceptable.

- 2.8.3 Electric damper actuators shall be spring return on outdoor air service.
- 2.8.4 Valves installed for outdoor service applications must be provided with actuators that operate satisfactorily at -30°C (-22°F) through 50°C (122°F).
- 2.8.5 Coupling shall be V-bolt dual nut clamp with a V-shaped, toothed cradle.
- 2.8.6 Mounting: actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
- 2.8.7 Fail-Safe Operation: mechanical, spring-return mechanism
- 2.8.8 Actuators to be overload protected electronically throughout rotation and come with electronic fail safe actuator for pressure independent valves 50mm (2-1/2") through 150mm (6").
- 2.8.9 Proportional actuators shall be fully programmable through an EEPROM without the use of actuator mounted switches.
- 2.8.10 Housing: minimum requirement NEMA type 2 / IP54 mounted in any orientation.
- 2.9 **POSITIONERS**
- 2.9.1 Positive positioning relays shall be provided on damper motors and valves when required to provide sufficient power, sequencing, repeatability, or speed of response. Positioner shall allow field adjustment of both starting pressure and operating span. Positioner shall provide an antilock feature and shall provide accurate positioning without excessive air bleed.
- 2.10 **SMOKE DAMPERS**
- 2.10.1 Provide Ruskin SD-35, Class I smoke dampers where indicated on the Drawings.
- 2.10.2 Provide parallel blade type dampers, suitable for horizontal or vertical mounting. Provide multiple dampers where sizes exceed code limitations.
- 2.10.3 Select dampers with airflow resistance not exceeding 13 Pa (0.05"

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w.g.) at design flow rates.

2.11 SMOKE DAMPER MOTORS

- 2.11.1 Size for torque required for damper seal at load conditions with one actuator per damper section. Mechanically paralleled or 'piggybacked' actuators are not permitted.
- 2.11.2 Coupling shall be V-bolt dual nut clamp with a V-shaped toothed cradle. Aluminum clamps or set screws are not acceptable.
- 2.11.3 Overload protection: microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.
- 2.11.4 Actuator timing shall be per OBC and NFPA requirements.
- 2.11.5 Temperature rating: actuator shall have a UL555S listing by the damper manufacturer for 177°C (350°F).
- 2.11.6 Proportional smoke and fire damper actuators shall meet all requirements specified above and shall modulate 0-100% open in response to a 2-10vdc or 4-20mA control signal. A 2-10vdc feedback output shall provide a 2-10vdc signal for position indication.
- 2.11.7 Balancing smoke and fire damper actuators shall meet all requirements specified above and shall include an integral adjustable maximum opening potentiometer for airflow adjustment.
- 2.11.8 A manual override winder and locking mechanism shall be provided for override operation of the actuator on a loss of power to the actuator.
- 2.11.9 Actuator to include auxiliary switches for signaling, fan control, or position indication.
- 2.11.10 Housing for combination fire/smoke damper actuator to be steel, aluminum is not acceptable.

2.12 GENERAL FIELD DEVICES

- 2.12.1 Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device

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manufacturers and as required for proper operation in the system.

- 2.12.2 BAS Contractor shall assure that all field devices are compatible with controller hardware and software.
- 2.12.3 Field devices specified herein are generally 'two-wire' type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, is not designed to work with 'two-wire' type transmitters, if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the BAS Contractor shall provide 'four-wire' type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.
- 2.12.4 For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, the BAS Contractor shall provide proper devices, including 120V power as required. Such devices shall have accuracy and repeatability equal to, or better than, the accuracy and repeatability listed for respective field devices.
- 2.12.5 Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis.
- 2.13 **ELECTRONIC TEMPERATURE SENSORS**
- 2.13.1 Supply factory calibrated temperature sensors that utilize 1000-Ohm nickel wire or platinum (RTDs).
- 2.13.2 Temperature sensors utilized for measuring duct temperatures shall incorporate an averaging style temperature element (RTD) of sufficient length to ensure a proper average of the variation across the full cross section of the duct.
- 2.13.3 Temperature sensors utilized for measurement of fluid temperatures shall incorporate a separate well of a material suitable for the service.
 - 2.13.3.1 Water service – brass
 - 2.13.3.2 Steam service - 304 SS
 - 2.13.3.3 Ethylene/propylene glycol service - 304 SS
- 2.13.4 Temperature sensors utilized for wall mounting in occupied spaces and connected to ASCs used for terminal unit control must be

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complete with a momentary contact switch for override initiation, concealed temperature setpoint adjustment and telephone style jack for connection of a portable service terminal.

2.13.5 Supply sensors with the following accuracy:

2.13.5.1 Duct and water insertion sensors +/- 0.5% at 20°C (68°F)

2.13.5.2 Duct averaging sensors +/- 1.0% at 20°C (68°F)

2.13.5.3 Space sensors +/- 0.5% at 20°C (68°F)

2.14 ELECTRONIC HUMIDITY SENSORS

2.14.1 Provide humidity sensors with a solid state sensing element suitable for operating ranges of 10 to 100% RH and an accuracy of +/- 3% over a range of 5 to 95% RH.

2.14.2 Incorporate in the humidity sensors a transducing circuit for conversion of the sensed variable to a voltage level for digital conversion.

2.15 PRESSURE SENSORS

2.15.1 Provide pressure transmitters suitable for continuous contact with the material being measured (i.e., air, water, glycol, or steam as applicable).

2.15.2 Pressure transmitters shall have a linear output of 0-5V. Pressure transmitters shall have a span of not greater than twice the static pressure at maximum flow or differential pressure at shut-off as applicable.

2.16 AIRFLOW MONITORING STATIONS

2.16.1 Airflow measuring stations must be designed and built to comply with, and provide results in accordance with accepted practice as defined for system testing in the ASHRAE Handbook of Fundamentals, as well as the Industrial Ventilation Handbook.

2.16.2 Where required, incorporate air straightening to ensure an accurate flow profile.

2.16.3 Utilize total pressure and static pressure probes and incorporate averaging manifolds, internal piping, and connections for an external differential pressure/flow transmitter. Hot wire anemometer technology is also acceptable

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2.16.4 Airflow stations incorporated into the flow channels of silencers must be a series of probes inserted and tubed together according to design criteria, to provide an acceptable airflow profile.

2.16.5 Connect air flow monitoring devices supplied as part of equipment such as air terminal units to the BAS as required based on the Sequences of Operation set out in Section 25 90 00.

2.17 PRESSURE SWITCHES

2.17.1 Supply pressure-sensing elements of the bourdon tube, bellows, or diaphragm type, with adjustable setpoint and differential.

2.17.2 Pressure switches to be snap action type rated at 120 Volts, 15 Amps AC or 24 Volts DC.

2.18 TEMPERATURE SWITCHES

2.18.1 Temperature sensing element shall be liquid, vapour, or bimetallic type.

2.18.2 Supply adjustable setpoint and differential.

2.18.3 Snap action type rated at 120 volts, 15 Amps, or 24 volts DC as required.

2.18.4 Sensors shall operate automatically and reset automatically. Temperature switches shall be of the following types:

2.18.4.1 Room Type suitable for wall mounting on standard electrical box with or without protective guard.

2.18.4.2 General Purpose Duct Type suitable for insertion into air ducts, insertion length of 450mm (18 inches).

2.18.4.3 Thermowell Type complete with compression fitting for 20mm ($\frac{3}{4}$ ") NPT well mounting of length of 100 mm (4 inches). Immersion wells shall be stainless steel.

2.18.4.4 Strap-on-Type complete with helical screw stainless steel clamps.

2.19 PRESSURE ELECTRIC SWITCHES

2.19.1 Provide pressure electric switches with diaphragm operated S.P.D.T. snap acting contacts with electrical rating suitable for application.

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2.19.2 Pressure electric switches must withstand up to 172 kPa (25 psig) and be provided with adjustable cut-in and cut-out settings between 21 and 138 kPa (3 and 20 psig).

2.20 CURRENT SENSING RELAYS

2.20.1 Supply current sensing relays in fan and pump motor starters to detect flow as required in the sequence of operation.

2.20.2 Supply current sensing relays complete with metering transformer ranged to match load being metered.

2.20.3 Provide adjustable latch level, a minimum differential of 10% of latch setting between latch level and release level, and an LED for local status indication.

2.20.4 Ensure relay contacts are compatible with control circuit voltage.

2.21 LOW TEMPERATURE LIMIT THERMOSTATS

2.21.1 Where shown on the Drawings or described in the sequences of operation, install low temperature limit thermostats complete with 6.1m (20'-0") of sensing capillary sensitive to 400mm (16") and manual reset. Provide one limit thermostat for approximately every 6 sq. m (65 sq. ft.) of duct area.

2.22 HIGH TEMPERATURE LIMIT THERMOSTATS

2.22.1 Where shown on the Drawings or described in the Sequences of Operation in this Section below for individual systems, provide high limit thermostats to shut down respective fan system(s).

2.22.2 Provide a single rod and tube type manual reset limit thermostat set at 57.5°C (135°F).

2.23 WATER FLOW SWITCHES

2.23.1 Supply paddle actuated water flow switches with snap acting S.P.D.T. contacts rated at 16 Amps 120/1/60 AC full load.

2.24 AIR PROVING SWITCHES

2.24.1 Air proving and motor status shall be performed by an adjustable latch level current switch. Upon motor current rise above setpoint, switch shall activate and status shall be proven.

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2.25 DAMPER STATUS SWITCHES

2.25.1 Damper status switches shall be lever operated, activated by damper blade movement, and mounted securely on damper frame.

2.25.2 Damper switch shall have contact rating of 5 Amperes at 120V AC and be C.S.A. approved.

2.26 CONTROL RELAYS

2.26.1 Supply and install load relays capable of switching 10 Amps at 120/1/60.

2.27 CONTROL TRANSFORMERS

2.27.1 Furnish and install control transformers as required. Control transformers shall be machine tool type, and shall be ULC and CSA listed. Primary and secondary sides shall have replaceable fuses in accordance with the NEC. Transformer shall be properly sized for application, and mounted in minimum NEMA 1 enclosure.

2.28 TIME DELAY RELAYS (TDR)

2.28.1 TDRs shall be capable of on or off delayed functions, with adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts, enclosed in a NEMA 1 enclosure.

2.28.2 TDRs shall have silver cadmium contacts with a minimum life span rating of one million operations. TDRs shall have solid state, plug-in type coils with transient suppression devices.

2.28.3 TDRs shall be ULC and CSA listed, Crouzet type.

2.29 ELECTRIC PUSH BUTTON SWITCH

2.29.1 Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type, and rated for minimum 120 VAC operation.

2.30 PILOT LIGHT

2.30.1 Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC.

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2.31 ALARM HORN

2.31.1 Panel-mounted audible alarm horn shall be continuous tone, 120 VAC Sonalert solid-state electronic signal.

2.32 ELECTRIC SELECTOR SWITCH (ESS)

2.32.1 Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 VAC operation.

2.33 NAMEPLATES

2.33.1 Duct and pipe mounted sensors and panels shall be provided with minimum size 75mm x 25mm x 3.2mm (3" x 1" x 1/8") lamacoid nameplates, clearly identifying the equipment and functions with letter and number designation. Nameplates shall be mechanically secured and listed in the Operating and Maintenance manual.

2.34 TESTING EQUIPMENT

2.34.1 The BAS Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. The BAS Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/- 0.5% accurate, test equipment shall be +/- 0.25% accurate over same range).

3 **EXECUTION**

3.1 PREPARATION

3.1.1 Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to the BAS Contractor.

3.2 GENERAL REQUIREMENTS

3.2.1 Installation shall meet or exceed all applicable federal, provincial, and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

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- 3.2.2 Install systems and materials in accordance with manufacturer's instructions, roughing-in Drawings and details shown on Drawings. Install electrical components and use electrical products complying with requirements of the Ontario Electrical Safety Code and all local codes.
- 3.2.3 Install all equipment, accessories, conduits, and interconnecting wiring in a neat manner by skilled and qualified workmen using the latest standard practices of the industry.
- 3.2.4 Notify the Consultant in writing of any conflict between these specifications and manufacturer's instructions.
- 3.2.5 Retain, at no additional cost to the owner, original equipment suppliers to provide contacts that are required on the point schedules and in the software and sequences specified. Provide the necessary relays and transformers required to interconnect equipment.
- 3.2.6 All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Anti-vibration mounts shall be provided, if required, for the proper isolation of equipment.
- 3.2.7 Install equipment to allow for easy maintenance access. Ensure equipment does not interfere in any way with access to adjacent equipment and personal traffic in the surrounding space.
- 3.2.8 Install equipment in locations providing ventilation and ambient conditions for its specified function.
- 3.2.9 Install all electrical wiring in conformance with the requirements of the local electrical authority, the Ontario Building Code and, unless otherwise indicated in the Contract Documents, the Specification Sections of Division 26 – Electrical.
- 3.2.10 Install low voltage wiring in accordance with the control manufacturer's recommendations. Run all wiring in a protective conduit in areas where exposed or where required to meet with applicable codes. Plenum rated (FT6) type cables may be used in accordance with applicable codes, in concealed, accessible locations such as ceiling spaces and wall cavities.
- 3.2.11 Shield and ground communication trunk wiring at a single end. Do not splice trunk cables.

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3.3 INSTALLATION OF CONTROLLED DEVICES AND SENSORS

- 3.3.1 Supply equipment to be installed under the work of other Divisions in accordance with their work schedule.
- 3.3.2 Coordinate final location of all sensors with the Consultant's field representative prior to installation.
- 3.3.3 Sensor assemblies and elements must be readily accessible. Provide access doors as required to allow for easy replacement and servicing.
- 3.3.4 Support field mounted transmitters and sensors on pipe stands or channel brackets.
- 3.3.5 Locate all sensing elements to correctly sense measured variable. Isolate elements from vibrations and temperatures, which could affect measurement.
- 3.3.6 Install temperature sensing elements with thermal paste to ensure accurate reading.
- 3.3.7 Install averaging type RTDs in serpentine configuration with adequate provision for the mechanical protection of the sensor. Support along its entire length.
- 3.3.8 Modifications to plenum and ductwork must achieve the intent of the Contract Documents and adhere to the following:
- 3.3.9 Mount sensors with extension necks such that access to sensors is not restricted by insulation.
- 3.3.10 Keep cutting to a minimum and perform in a neat and workmanlike manner.
- 3.3.11 Provide patches and access covers of the same material and thickness as adjoining ductwork. Provide necessary reinforcing and fastening materials.
- 3.3.12 Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.
- 3.3.13 Provide gaskets, seals, and insulation to restore to, or exceed as found conditions in areas where the BAS Contractor has made modifications.

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- 3.3.14 All damper actuators shall be rigidly mounted and supplied with heavy-duty linkage consisting of a crank arm, pushrod, and swivel ball joint to connect to the damper shaft. Secure linkages in such a manner as to prevent slipping under normal operating torque.
- 3.3.15 Where the point schedules indicate that auxiliary contact provision, provide all instrumentation, wiring, conduit, power supplies, and services as required to integrate these points into the BAS.
- 3.3.16 Provide interposing and motor control relays at the local item of equipment or at the associated MCC as applicable. Provide all relays, wiring, conduit, power supplies, and services as required integrating these points into the BAS.
- 3.3.17 Control Wiring:
- 3.3.17.1 The term "control wiring" is defined to include providing of wire, conduit, and miscellaneous materials as required for mounting and connection of electric control devices.
- 3.3.17.2 Install complete wiring system for electric control systems. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed. Installation of wiring shall generally follow building lines. Install in accordance with the latest edition of the Ontario Electrical Safety Code and Division 26 - Electrical. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.
- 3.3.17.3 Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened.
- 3.3.17.4 Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over 30V. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.
- 3.3.17.5 All WAN and LAN communication wiring shield shall be terminated as recommended by controller manufacturer. All WAN and LAN communication wiring shall be labeled with a network number, device ID at each termination and shall correspond with the WAN and LAN system architecture and floor plan submittals.
- 3.3.17.6 Install all control wiring external to panels in electric metallic tubing or raceway. Installation of wiring shall generally follow building

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lines. Provide compression type connectors. Install wiring in galvanized rigid steel conduit at all exterior locations and where subjected to moisture. Install in PVC Schedule 40 conduit if encased in concrete. All conduits penetrating partitions, walls or floors shall be sealed with a submitted and approved fire/smoke sealant material to prevent migration of air through the conduit system.

- 3.3.17.6.1 The BAS Contractor shall be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance.
- 3.3.17.6.2 Accessible locations are defined as areas inside mechanical equipment enclosures, such as heating and cooling units, instrument panels etc.; in accessible pipe chases with easy access, or suspended ceilings with easy access. Installation of wiring shall generally follow building lines.
- 3.3.17.6.3 Run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring rings) away from areas of normal access. Tie and support conductors neatly with suitable nylon ties and not to exceed 1.52m (5 foot) intervals.
- 3.3.17.6.4 Conductors shall not be supported by the ceiling system or ceiling support system. Conductors shall be pulled tight and be installed as high as practically possible in ceiling cavities. Wiring shall not be laid on the ceiling or duct.
- 3.3.17.6.5 Conductors shall not be installed between the top cord of a joist or beam and the bottom of roof decking.
- 3.3.17.7 Communication cabling shall be provided in an Owner approved color dedicated to the BAS.
- 3.3.17.8 Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.
- 3.3.18 Install control valves so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.
- 3.3.19 Averaging temperature sensors shall cover no more than 0.61

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sq.m per linear meter (2 sq.ft per linear foot) of sensor length except where indicated. Sensor shall be installed in location where flow is sufficiently homogeneous and adequately mixed. Install averaging sensors in a serpentine configuration with adequate provision for the mechanical protection of the sensor. Support along its entire length.

- 3.3.20 Install airflow measuring stations per manufacturer's recommendations in an unobstructed straight length of duct (except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFM station manufacturer.
- 3.3.21 Install fluid flow sensors per manufacturer's recommendations in an unobstructed straight length of pipe.
- 3.3.22 Provide element guard for relative humidity sensors as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.
- 3.3.23 Water differential pressure transmitters shall be installed in a valve bypass arrangement to protect against over pressure damaging the transmitter. Establish required locations and coordinate installation of valve bypass with the respective Subcontractors.
- 3.3.24 Install steam differential pressure transmitters as shown on the Drawings per manufacturer's instructions.
- 3.3.25 Install pipe surface mount temperature sensors with thermally conductive paste at pipe contact point. Where sensor is to be installed on an insulated pipe, the BAS Contractor shall neatly cut insulation, install sensor, repair or replace insulation and vapor barrier, and adequately seal vapor barrier.
- 3.3.26 Where possible, install flow switches in a straight run of pipe at least 15 diameters in length to minimize false indications.
- 3.3.27 Adjust current switches for motor status monitoring so that setpoint is below minimum operating current and above motor no load current.
- 3.3.28 Supply Duct Pressure Transmitters:
- 3.3.28.1 Install pressure taps with at least four (4) 'round equivalent' duct

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diameters of straight duct with no takeoffs upstream. Install static pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions. Locate the transmitter at an accessible location to facilitate calibration.

- 3.3.28.2 On VAV Systems, locate down-duct transmitter pressure tips approximately 2/3 of the hydraulic distance to the most remote terminal in the air system.

3.4 IDENTIFICATION OF EQUIPMENT

- 3.4.1 Identify each piece of equipment, including sensors, controlled devices, and control panels, with a nameplate identifying the equipment and functions with a letter and number designation.
- 3.4.2 Nameplates shall be minimum size 75mm x 25mm (3" x 1") and 3.2mm (1/8") thick laminated plastic with black face and white center and 6.4mm (1/4") deep engraved lettering. Nameplates shall be securely attached to the equipment.
- 3.4.3 Printed nametags are acceptable for cabinet mounted components providing they are securely attached.

3.5 ACCEPTANCE AND TESTING PROCEDURES

- 3.5.1 The BAS Contractor shall request completion acceptance in writing and advise the Consultant of situations that would prevent a complete testing of overall system performance.
- 3.5.2 Work and/or systems installed under this Division and under Divisions 21, 22 and 23 shall be fully functioning prior to Demonstration and Acceptance Phase. The BAS Contractor shall start, test, adjust, and calibrate all work and/or systems under this Contract, as described below:
- 3.5.2.1 Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.
- 3.5.2.2 Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
- 3.5.2.3 Verify integrity/safety of all electrical connections.
- 3.5.2.4 Coordinate with the Subcontractor responsible for the TAB work to obtain control settings that are determined from balancing procedures. Record the following control settings as obtained from

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the Subcontractor responsible for the TAB work, and note any TAB deficiencies in the BAS Start-Up Report:

- 3.5.2.4.1 Optimum duct static pressure setpoints for VAV air handling units.
- 3.5.2.4.2 Minimum outside air damper settings for air handling units.
- 3.5.2.4.3 Optimum differential pressure setpoints for variable speed pumping systems.
- 3.5.2.4.4 Calibration parameters for flow control devices such as VAV terminal units and flow measuring stations.
- 3.5.2.5 The BAS Contractor shall provide a hand-held device as a minimum to the Subcontractor responsible for the TAB work to facilitate calibration. Connection for any given device shall be local to it (i.e. at the VAV terminal unit or at the thermostat). Hand-held device or portable operator's terminal shall allow querying and editing of parameters required for proper calibration and start-up.
- 3.5.2.6 Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5 percent accurate, test equipment shall be +/-0.25 percent accurate over same range). Record the measured value and displayed value for each device in the BAS Start-up Report.
- 3.5.2.7 Check and set zero and span adjustments for all transducers and transmitters.
- 3.5.2.8 For dampers and valves:
 - 3.5.2.8.1 Check for adequate installation including free travel throughout range and adequate seal.
 - 3.5.2.8.2 Where loops are sequenced, check for proper control without overlap.
- 3.5.2.9 For actuators:
 - 3.5.2.9.1 Check to insure that device seals tightly when the appropriate signal is applied to the operator.
 - 3.5.2.9.2 Check for appropriate fail position, and that the stroke and range is as required.

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- 3.5.2.9.3 For pneumatic operators, adjust the operator spring compression as required to achieve close-off. If positioner or volume booster is installed on the operator, calibrate per manufacturer's procedure to achieve spring range indicated. Check split-range positioners to verify proper operation. Record settings for each device in the BAS Pre-Commissioning Report.
- 3.5.2.9.4 For sequenced electronic actuators, calibrate per manufacturer's instructions to required ranges.
- 3.5.2.10 Check each digital control point by making a comparison between the control command at the CU and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the Operator Interface display. Record the results for each device in the BAS Start-Up Report.
- 3.5.2.11 For outputs to reset other manufacturer's devices (for example, VSDs) and for feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.
- 3.5.3 Sensor Checkout and Calibration:
- 3.5.3.1 Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.1 degrees C (0.2 degrees F) of each other for temperature and within a tolerance equal to 2 percent of the reading of each other for pressure. Tolerances for critical applications may be tighter.
- 3.5.3.2 Calibrate all sensors using one of the following procedures:
- 3.5.3.2.1 Sensors without transmitters: Make a reading with a calibrated test instrument within 150mm (6 inches) of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gauge or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20 percentage of the expected range.
- 3.5.3.2.2 Sensors with transmitters: Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between

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transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until the ammeter reads 4 mA. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the OI. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 150mm (6 inches) of the site sensor. Verify that the sensor reading (via the permanent thermostat, gauge or BAS) is within the tolerances specified. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

- 3.5.3.3 Sensors shall be within the tolerances specified for the device.
- 3.5.4 Coil Valve Leak Check:
 - 3.5.4.1 Verify proper close-off of the valves. Ensure the valve seats properly seat by simulating the maximum anticipated pressure difference across the circuit. Demonstrate to the Owner the verification of zero flow by measuring the coil differential pressure. If there is pressure differential, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.
- 3.5.5 Valve Stroke Setup and Check:
 - 3.5.5.1 For all valve and actuator positions checked, verify the actual position against the Operator Interface readout.
 - 3.5.5.2 Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command the valve to various few intermediate positions. If actual valve position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).
- 3.5.6 After completion of installation and in cooperation with Subcontractors responsible for the related work of other Specification Sections, adjust each control device and component to ensure that the operations are in accordance with the Sequences of Operation specified in Section 20 95 00.

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1 **GENERAL**

1.1 GENERAL

1.1.1 Sections 20 00 00 and 25 00 00 – General Requirements shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Operator Workstations.

1.2.1.2 Control System Servers.

1.2.1.3 Portable Operator Terminal / Remote Workstation.

1.2.2 Furnish and install all Operator Interfaces and Control System Servers as required for the BAS functions specified in the Contract Documents. All computers shall be warranted by the manufacturer for a period of one year after final acceptance.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All materials shall meet or exceed all applicable referenced standards, and conform to codes and ordinances of authorities having jurisdiction.

2.1.2 The make and model of control system server computers, personal computers (PC), notebook PC's, monitors, and printers shall comply with Owner's current standards for desktop personal computers as of the date of the Substantial Performance of the Work. Contact the Owner for the current computer hardware standards.

2.1.3 Operating system for operator workstation shall comply with the Owner's current standards for desktop personal computers as of the date of the Substantial Performance of the Work. Contact the Owner for the current computer software standards.

2.2 CONTROL SYSTEMS APPLICATION SERVER (CSS)

2.2.1 Provide Controls Systems Application Server to archive historical

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data including trends, alarm and event histories and transaction logs.

2.2.2 Server shall be an IBM compatible computer platform. Minimum 2 GB RAM, 19" LCD monitor, and 500 GB hard-drive. DVD Read / Write drive shall be provided for system backup use.

2.2.3 One printer shall be provided for information summaries, custom reports, and graphical printing. The printer shall be capable of six (6) pages per minute at a resolution of 600 dpi, and use inkjet technology.

2.2.4 Equip this Server with the same software tool set that is located in the Primary Controls Systems Application Nodes for system configuration, custom logic definition, and for colour graphic configuration.

2.2.5 Access to all information on the Controls Systems Server shall be through the same Operator Interface functionality used to access individual nodes. When logged onto a Server the Operator will be able to also interact with any of the primary Nodes on the Controls Systems Application.

2.3 OPERATOR WORKSTATION (OWS)

2.3.1 The Operator Interface provided shall include the functionality to selectively combine data and information from any system element or component in the Controls Systems Application on a single Browser window display panel at the Operator's option. This shall include both current information and historical data stored on the Server.

2.3.2 The Controls Systems Application Operator Workstation (OWS) shall operate on Microsoft® Windows 8 or other approved platform, with the same hardware as described under the CSS.

2.3.2.1 The BAS Contractor shall provide a modem for connection to the Owner's paging service.

2.3.3 Operator Workstations shall be placed in the mechanical room or as directed by the Owner.

2.4 PORTABLE OPERATOR TERMINAL (POT) / REMOTE WORKSTATION

2.4.1 Portable Operator Terminal shall support system management by

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connection to the controllers and by connection via the Internet while serving as the remote workstation.

- 2.4.2 Provide one notebook personal computer (PC) that meets or exceeds the minimum requirements of the BAS software and meets or exceeds Owner's minimum requirements. Notebook PC shall contain a DVD-RW Drive.
- 2.4.3 Provide carrying case and extra battery.
- 2.4.4 Operating system for operator workstation shall be Microsoft Windows 8 Professional.
- 2.4.5 Provide additional hardware, video drivers, serial ports, etc., to facilitate all control functions and software requirements specified for the building automation system.
- 2.4.6 Provide all controller configurations, interface software, and/or plug-ins for all devices applicable. All shall be loaded and functional. Provide all required interface cables required to connect to all networks, routers, controllers, SDs, etc.
- 2.4.7 Wherever a POT connection point is not accessible in the same room as the device controlled, Contractor shall provide a wireless system, to permit configuration, testing, and operation.
- 2.4.8 BAS licensing for this POT shall allow unlimited access to all aspects of the any manufacturer's system including system access, workstations, points, programming, database management, graphics etc.
- 2.4.9 No restrictions shall be placed on the license.
- 2.4.10 All operator interfaces, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the Owner.
- 2.5 **UNINTERRUPTABLE POWER SUPPLY**
- 2.5.1 Provide an uninterruptible power supply system (UPS) providing battery backup for each operator workstation, server and peripheral devices.
- 2.5.1.1 UPS shall protect against blackouts, brownouts, surges, and noise.
- 2.5.1.2 UPS shall include LAN port and modem line surge protection.

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- 2.5.1.3 UPS shall be sized for a 7-minute full load runtime, 23-minute ½-load runtime, with a typical runtime of up to 60 minutes. Transfer time shall be 2-4 milliseconds.
- 2.5.1.4 UPS shall provide a 480 Joule suppression rating and current suppression protection for 36,000 Amps and provide 90 percent recharge capability in two to four hours. Suppression response time shall be instantaneous.
- 2.5.1.5 UPS low voltage switching shall occur when supply voltage is less than 94 Volts. UPS shall be provided with modem surge suppression and LAN port connections.

3 **EXECUTION**

3.1 INSTALLATION

- 3.1.1 Installation shall meet or exceed all applicable federal requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- 3.1.2 All installation shall be in accordance with manufacturer's published recommendations.
- 3.1.3 Set up workstations and printers as indicated on the Drawings. Install all software and verify that the systems are fully operational.
- 3.1.4 No license, software component, key or any piece of information required for installing, configuring, operating, diagnosing and maintaining the system shall be withheld from the Owner.
- 3.1.5 Install electronic control system Operation and Maintenance Manuals, programming guides, network configuration tools, and control Shop Drawings etc. on each OWS and CSS. Provide interface or shortcuts to guide user to the appropriate information.
- 3.1.6 Set up portable operator terminal and configure it as the remote workstation. Install all software and verify that the system is operational.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Sections 20 00 00 and 25 00 00 – General Requirements shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Application Nodes (ANs)

1.2.1.2 Application Specific Controllers (ASCs)

1.2.2 Furnish and install DDC Control units and/or Smart Devices required to support specified building automation system functions.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All materials shall meet or exceed all applicable referenced standards, federal requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 CONTROLLERS – APPLICATION NODES (AN)

2.2.1 Controls AN shall provide both standalone and networked direct digital control of mechanical and electrical building systems as required by the Specifications. The primary AN shall support a minimum of [2,000] field points together with all associated features, sequences, schedules, applications as required for fully functional distributed processing operations.

2.2.2 A dedicated AN shall be configured and provided for each building.

2.2.3 Each AN shall retain program, control algorithms, and setpoint information for at least 72 hours in the event of a power failure and shall return to normal operation upon stable restoration of normal line power.

2.2.4 Each AN shall monitor and report its communication status to the Controls Systems Application. The Controls Systems shall provide a system advisory upon communication failure and restoration.

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- 2.2.5 Provide a means to prevent unauthorized personnel from accessing setpoint adjustments and equipment control definitions at the AN.
- 2.2.6 The AN shall provide the functionality to download and upload configuration data, both locally at the AN and via the Controls Application networks.
- 2.2.7 The AN shall perform the functional monitoring of all Controls Application variables, both from real hardware points, software variables, and controller parameters such as setpoints.
- 2.2.8 The primary AN shall manage and direct all information traffic on the Tier 1 network, between the Tier 1 and Tier 2 networks and to the Server(s).
- 2.2.9 All AN on the Tier 1 network shall be equipped with all software and functionality necessary to operate the complete user interface, including graphics, via a Browser connected to the Node on the network or directly via a local port on the AN.
- 2.2.10 The AN shall be capable of direct connection to multiple field busses using different protocols simultaneously as indicated below. Should the AN not support multiple field busses then install multiple AN in parallel to achieve this functionality.
 - 2.2.10.1 An RS-485 serial field bus such as MSTP or the manufacturer's open field bus.
 - 2.2.10.2 A LON field bus for supervision and control of LON based controllers that conform to the Lon Talk standard.
- 2.2.11 The AN shall integrate data from both field busses into a common and conformal object structure. Data from both field busses shall appear in common displays throughout the Operator Interface in the same format. Conformal formatting shall be provided for each type of data not dependent on the type of field bus from which the data originated.
- 2.2.12 The AN shall be designed, packaged, installed, programmed and commissioned in consideration of their specific service and prevailing operating conditions. They shall be proven standard product of their original manufacturer and not a custom product for this Project.
- 2.2.13 A failure at an AN shall not cause failures or non-normal operation

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at any other system AN other than the possible loss of active real-time information from the failed AN.

2.2.14 Ancillary AN equipment, including interfaces and power supplies, shall not be operated at more than 80% of their rated service capacity.

2.2.15 Each AN shall report its communication status to the Application. The Application shall provide a system advisory upon communication failure and restoration.

2.2.16 The AN shall incorporate the ability to download and upload configuration data, both locally at the AN and via the Application communications network.

2.3 APPLICATION SPECIFIC CONTROLLERS (ASCS)

2.3.1 Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor. Each ASC shall operate as a stand-alone controller capable of performing its specified control sequences.

2.3.2 ASCs shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally stand-alone fashion.

2.3.3 ASCs shall have a library of control processes to perform the sequence of operation specified in the "Execution" portion of this specification. Control processes shall include:

2.3.3.1 Two Position Control

2.3.3.2 Proportional, Integral, plus Derivative Control

2.3.3.3 Industry standard heat pump control process

2.3.3.4 Industry standard AC system control process

2.3.3.5 Industry standard AHU system control process

2.3.4 Each ASC shall have sufficient memory to support its own operating system and databases, including control processes, energy management applications, operator I/O and local alarm management.

2.3.5 Each ASC shall perform its own limit and status monitoring and analysis to maximize network performance by reducing

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unnecessary communications.

2.3.6 Powerfail Protection

2.3.6.1 All controller setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the ASC.

2.3.6.2 All controller memory containing program configuration and control parameters shall be either non-volatile EEPROM/EPROM memory or shall be provided with battery back-up sufficient to sustain the contents of RAM memory for a minimum of one (1) year. Alternatively, provide 72-hour battery backup for program & data memory.

2.3.7 Configuration and Download

2.3.7.1 The ASCs shall have the capability of receiving configuration and program loading by all of the following:

2.3.7.1.1 Locally, via a direct portable laptop service tool;

2.3.7.1.2 Over the network, from the portable laptop service tool;

2.3.7.1.3 From the Operator Workstation, via the communication networks.

3 EXECUTION

3.1 PREPARATION

3.1.1 Examine areas and conditions under which control systems are to be installed. Do not proceed with the Work until unsatisfactory conditions have been corrected in manner acceptable to the BAS Contractor.

3.2 INSTALLATION

3.2.1 Installation shall meet or exceed all applicable federal requirements, referenced standards, and conform to codes and ordinances of authorities having jurisdiction.

3.2.2 All installation shall be in accordance with manufacturer's published recommendations.

3.2.3 All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Anti-vibration mounts to be

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provided, if required, for the proper isolation of equipment.

3.2.4 Install equipment to allow for easy maintenance access. Ensure equipment does not interfere in any way with access to adjacent equipment and personal traffic in the surrounding space.

3.2.5 Install equipment in locations providing ventilation and ambient conditions for its specified function.

3.3 CONTROLLER QUALITY AND LOCATION

3.3.1 Digital Control Stations (DCS) are referenced to indicate allocation of points to each DCS and DCS location. Digital control stations shall consist of one or multiple controllers to meet requirements of the Division 25 Specification Sections.

3.3.2 Where a DCS is referenced, the BAS Contractor shall provide at least one (1) controller, and additional controllers as required, in sufficient quantity to meet the requirements of the Division 25 Specification Sections. Restrictions in applying controllers are specified under this Section. The BAS Contractor shall extend power to the DCS from an acceptable power panel. If the BAS supplier wishes to further distribute panels to other locations, the BAS Contractor is responsible for extending power to that location also. Furthermore, the BAS Contractor is responsible for ensuring adequate locations for the panels that do not interfere with other requirements of the Project and maintain adequate clearance for maintenance access.

3.3.3 The BAS Contractor shall locate DCS's as referenced in the Contract Documents. It is the BAS Contractor's responsibility to provide enough controllers to ensure a completely functioning system, according to the point list and sequence of operations.

3.3.4 The BAS Contractor shall provide a minimum of the following:

3.3.4.1 One DCS (including at least one controller) in each chilled water/hot water plant mechanical room

3.3.4.2 One DCS (including at least one controller) for each air handler located in applicable mechanical room

3.3.4.3 One DCS (including at least one controller) for each critical fan system

3.3.4.4 One DCS (including at least one controller) for each pumping

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system

3.3.4.5 One DCS (including at least one controller) for each steam pressure reducing station

3.3.4.6 One controller for each piece of terminal equipment located at the equipment.

3.4 SURGE PROTECTION

3.4.1 The BAS Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all BCs, AAC/ASCS, routers, gateways, and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10 percent above or below measured nominal value, with no effect on hardware, software, communications, and data storage.

3.5 CONTROL POWER SOURCE AND SUPPLY

3.5.1 The BAS Contractor shall extend all power source wiring required for operation of all equipment and devices provided under this Section.

3.5.2 General requirements for obtaining power include the following:

3.5.2.1 In the case where additional power is required, obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 600V source, obtain power from the electrically most proximate 120V source fed from a common origin.

3.5.2.2 Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source as the equipment. If the equipment's control transformer is large enough and is the correct voltage to supply the controls, it may be used. If the equipment's control transformer is not large enough or of the correct voltage to supply the controls, provide separate transformer

3.5.2.3 Where a controller controls multiple systems on varying levels of power reliability (normal, emergency, and/or interruptible), the controller shall be powered by the highest level of reliability served. Furthermore, the controller in that condition shall monitor each power type served to determine so logic can assess whether a

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failure is due to a power loss and respond appropriately. A three-phase monitor into a digital input shall suffice as power monitoring.

3.6 IDENTIFICATION OF EQUIPMENT

- 3.6.1 Identify each piece of equipment, including sensors, controlled devices, and control panels, with a nameplate identifying the equipment and functions with a letter and number designation.
- 3.6.2 Nameplates shall be minimum size 75mm x 25mm (3" x 1") and 3.2mm (1/8") thick laminated plastic with black face and white center and 6.4mm (1/4") deep engraved lettering. Nameplates shall be securely attached to the equipment.
- 3.6.3 Printed nametags are acceptable for cabinet mounted components providing they are securely attached.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Sections 20 00 00 and 25 00 00 – General Requirements shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, including calibration, commissioning, software programming and data base generation, generation of colour graphics and additional work necessary to provide a complete and fully operating system.

1.3 LICENSING

1.3.1 Provide or upgrade all licensing for all software packages at all required workstations. BAS licensing shall allow unlimited simultaneous users for access to all aspects of the system including system access, workstations, points, programming, database management, graphics etc. No restrictions shall be placed on the licensing. All operator interfaces, programming environment, networking, database management, and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the Owner.

1.3.2 All software should be available on all Operator Workstations (OWS) provided, and on all Portable Operator Terminals. Hardware and software keys to provide all rights shall be installed on all workstations. At least two (2) sets of compact discs or USB drives shall be provided with backup software for all software provided, so that the Owner may reinstall any software as necessary. Include all licensing for workstation operating systems, and all required third-party software licenses.

1.3.3 Provide licensing and original software copies for each OWS.

1.3.4 Provide licensing and original software copies for each remote graphic workstation. Licenses for remote graphic workstations shall allow for access to any Site and shall not be restricted to accessing only the LANs included in this Project.

1.3.5 In the last month of the Warranty Period, upgrade all software and firmware packages to the latest release (version) in effect at the end of the Warranty Period.

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2 PRODUCTS

2.1 GENERAL

2.1.1 All materials shall meet or exceed all applicable referenced standards, federal, provincial, and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 OPERATOR INTERFACES

2.2.1 The Controls Systems Operator Interfaces shall be user friendly, readily understood and shall make maximum use of colours, graphics, icons, embedded images, animation, text based information and data visualization techniques to enhance and simplify the use and understanding of the displays by authorized users at the Operator's Workstation (OWS).

2.2.2 User access shall be protected by a flexible and Owner redefinable software-based password access protection. Password protection shall be multi-level and partitionable to accommodate the varied access requirements of the different user groups to which individual users may be assigned. Provide the means to define unique access privileges for each individual authorized user. Provide the means to on-line manage password access control under the control of a project specific Master Password. Provide an audit trail of all user activity on the Controls Systems including all actions and changes.

2.2.3 The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:

2.2.3.1 User access for selective information retrieval and control command execution.

2.2.3.2 Monitoring and reporting.

2.2.3.3 Alarm and non-normal condition annunciation.

2.2.3.4 Selective operator override and other control actions.

2.2.3.5 Information archiving, manipulation, formatting, display, and reporting.

2.2.3.6 Controls Systems internal performance supervision and diagnostics.

2.2.3.7 On-line access to user HELP menus.

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- 2.2.3.8 On-line access to current as-built records and documentation. At minimum, one (1) copy of all record documentation shall be stored on a designated OWS or Server and be accessible to the Owner.
- 2.2.3.9 Means for the controlled re-programming, re-configuration of systems operation and for the manipulation of database information in compliance with the prevailing codes, approvals, and regulations for the component applications and elements.
- 2.2.3.10 Means to archive all Controls Systems Contract Project specific configuration databases, software programs, and other pertinent operational data such that any component of the software and project specific operational databases may be reloaded on Site from archived data.
- 2.2.3.11 Provide on-line reports and displays making maximized use of simple English language descriptions and readily understood acronyms, abbreviations, icons and the like to assist user understanding and interpretation. All text naming conventions shall be consistent in their use and application throughout the Controls Systems.
- 2.3 **OPERATOR WORKSTATIONS**
- 2.3.1 The Operator Interface provided shall include the functionality to selectively combine data and information from any system element or component in the Controls Systems Application on a single Browser window display panel at the Operator's option. This shall include both current information and historical data stored on the Server.
- 2.3.2 Each Controls Systems Application fixed and portable OWS shall be on-line configurable for specific functionalities and associated groups of system points and elements.
- 2.3.3 Navigation Trees
- 2.3.3.1 Provide the capability to display multiple navigation trees that aid the operator in navigating throughout all systems and points connected. At minimum, provide a tree that identifies all systems on the Controls Systems networks.
- 2.3.3.2 Provide the capability for the Operator to add custom trees. The Operator shall be able to define any logical grouping of systems or points and arrange them on the tree in any selected order. Provide the capability to nest groups within other groups. Provide at

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minimum for five levels of nesting.

- 2.3.3.3 The navigation trees shall be “dockable” to other displays in the Operator interface including graphic displays. The trees shall appear as part of the display and may be individually detached and minimized to the Windows task bar or closed. Provide for a single keystroke to reattach the navigation tree to a primary display.
- 2.3.4 Divisible Display Windows
 - 2.3.4.1 Provide for the operator to divide the display area within a single Browser window into multiple display panels. The content of each display panel can be any of the standard summaries and graphics provided in the Controls Systems Application.
 - 2.3.4.2 Provide each display panel with minimize, maximize, and close icons.
- 2.3.5 Alarms
 - 2.3.5.1 Alarms shall be routed directly from primary Controls Systems Application Nodes to OWS and Server. Provide for specific alarms from specific points to be routed to selectable OWS and Server. The alarm management portion of the Controls Systems software shall, at minimum, provide the following functions:
 - 2.3.5.2 Log date and time of alarm occurrence.
 - 2.3.5.3 Generate a “Pop-Up” window on the Browser display panel, with audible alarm, informing the Operator that an alarm has been received.
 - 2.3.5.4 Allow an Operator, with the appropriate password, to acknowledge, temporarily silence or cancel an alarm.
 - 2.3.5.5 Provide an audit trail on hard drive for alarms by recording user acknowledgement, deletion, or cancelling of an alarm. The audit trail shall include the ID of the user, the alarm, the action taken on the alarm and a time/date stamp.
 - 2.3.5.6 Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop-up window described herein. Controls Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
 - 2.3.5.7 Provide for any attribute of any object in the Controls Systems to

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be designated to report as an alarm.

- 2.3.5.8 The Controls Systems Application shall annunciate systems diagnostic alarms indicating system failures and non-normal operating conditions.
- 2.3.5.9 The Controls Systems Application shall annunciate controls alarms at minimum as required by Part 3.
- 2.3.5.10 Provide the on-line means to display alarms within the Browser windows by date/time of occurrence, priority class, point designation, value, or other defined text keywords.
- 2.3.6 Operator Transaction Archiving
- 2.3.6.1 Provide the means to automatically archive all Operator activities on the Controls Systems Application and for the recall of same for reporting.
- 2.3.6.2 Provide the means to sort and report archived activities by Operator, date/time, activity type and system area.
- 2.3.6.3 Provide access protection to preclude the unauthorized removal or tampering with archived records.
- 2.3.6.4 Provide management support facilities for the deletion and re-initializing of archived record logs under Master Password control or equal means.
- 2.3.7 Reports
- 2.3.7.1 Reports shall be generated and directed to one or more of the following: User interface displays, printers archived at the Owner's defined option. As a minimum, the Controls Systems Application shall provide the following reports:
- All points in the Controls Systems Application.
 - All points in a specific Controls Systems.
 - All points in a user-defined group of points.
 - All points currently in alarm.
 - All points locked out.
 - All Controls Systems Application schedules.

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- All user defined and adjustable variables, schedules, interlocks, diagnostics, systems status reports, and the like.

2.3.7.2 Provide all applicable original manufacturers standard reports for the Controls Systems.

2.3.8 Dynamic Colour Graphics

2.3.8.1 Provide for any number of real-time colour graphic displays shall be able to be generated and displayed in the Controls Systems Application limited only by memory data storage capacity.

2.3.8.2 Graphics shall be based on Scalar Vector Graphic (SVG) technology.

2.3.8.3 Values of real-time attributes displayed on the graphics shall be dynamic and updated on the displays.

2.3.8.4 The graphic displays shall be able to display and provide animation based on real-time data that is acquired, derived, or entered into the operating Controls Systems.

2.3.8.5 Provide for the Owner to be able to change values (setpoints) and states in system controlled equipment directly from the graphic display.

2.3.8.6 Provide a graphic editing tool that allows for the creation and editing of graphic files. It shall be possible to edit the graphics directly while they are on line, or at an off line location for later downloading to the AN.

2.3.8.7 Provide a complete user expandable symbol library containing all of the basic symbols used to represent components of a typical system. Implementing these symbols in a graphic shall involve dragging and dropping them from the library to the graphic.

2.3.9 Schedules

2.3.9.1 Provide multiple schedule input forms for automatic time-of-day scheduling and override scheduling of operations. At a minimum, the following spreadsheet types shall be accommodated:

- Weekly schedules.
- Temporary override schedules.
- Special "Only Active If Today Is A Holiday" schedules.

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- Monthly schedules.

2.3.9.2 Schedules shall be provided for each group, system, and sub-system in the Controls Systems Application. It shall be possible to include all or any commandable points residing within the Controls Systems in any custom schedule. Each point shall have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system. Scheduling and rescheduling of points shall be accomplished easily via the system schedule spreadsheets.

2.3.9.3 Multiple monthly calendars for a 12-month period shall be provided that allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

2.3.10 Historical Trending And Data Collection

2.3.10.1 Trend and store point history data for all actual and virtual (software) points and values as required by the Owner.

2.3.10.2 The trend data shall be stored in a manner that allows custom queries and reports using industry-standard software tools.

2.3.10.3 At a minimum, provide the capability to perform statistical functions on the historical database:

- Average.
- Arithmetic mean.
- Maximum/minimum values.
- Range – difference between minimum and maximum values.
- Standard deviation.
- Sum of all values.
- Variance.

2.3.11 Operator Access Security (Combined Password and User ID)

2.3.11.1 Provide for Operator access into the Controls Systems via the use of on-line Owner defined software Password and User Identification (ID) pairs, unique for each Operator and unique throughout the Controls Systems Application, to supplement

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standard password access control.

- 2.3.11.2 Stored password/user ID definitions shall be stored in encrypted formats whether at the Controls Server or at the application node.
- 2.3.11.3 Password logins shall not be echoed on any screen or printer except during Master Password definition processes. An Operator defining a password shall be required to re-enter to confirm authenticity.
- 2.3.11.4 Operator access privileges shall be definable in terms of functions and Project areas.
- 2.3.11.5 As part of the access privileges definition for each user the Owner shall be able to define at minimum the following:
 - Access times by day.
 - Permanent or temporary, with expiry date, password.
 - Number of incorrect access attempts allowed before the password is disabled.
 - Whether or not the Operators are able to redefine their own password.
 - A field for the Operator's e-mail address.
 - A field for the Operator's contact phone number.
 - Definition of the Operator's access privilege functionalities including viewing only, full control, selected functions, etc.
- 2.3.12 Texting/E-mail Notification
 - 2.3.12.1 Provide the means of automatic alphanumeric notification of personnel for Owner defined events.
 - 2.3.12.2 The Controls System shall support both numeric and alphanumeric notification, using Alphanumeric, PET, or IXO Protocol at the Owner's option and/or service by the owners wireless service provider.
 - 2.3.12.3 Users shall have the ability to modify the phone number or message to be displayed on the pager through the Controls System software.

3 EXECUTION

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3.1 SYSTEM CONFIGURATION

3.1.1 Contractor shall thoroughly and completely configure BAS system software, supplemental software, network communications, CSS, OWS, remote operator workstation, portable operators terminal, printer, and remote communications.

3.2 OPERATOR INTERFACES

3.2.1 Set up workstations and printers as indicated on the Drawings. Install all software and verify that the systems are fully operational.

3.2.2 No license, software component, key or any piece of information required for installing, configuring, operating, diagnosing and maintaining the system shall be withheld from the Owner.

3.2.3 Install electronic control system Operation and Maintenance Manuals, programming guides, network configuration tools, and control Shop Drawings etc. on each OWS and CSS. Provide interface or shortcuts to guide user to the appropriate information.

3.2.4 Set up portable operator terminal and configure it as the remote workstation. Install all software and verify that the system is operational.

3.3 GRAPHIC SCREENS

3.3.1 Floor Plan Screens: The Contract Document Drawings will be made available to the Contractor in AutoCAD format upon request. These Drawings may be used only for developing backgrounds for specified graphic screens; however the Owner does not guarantee the suitability of these Drawings for the Contractor's purpose. Graphic Screens shall be submitted for approval.

3.3.1.1 Provide graphic floor plan screens for each floor of each building.

3.3.1.1.1 Indicate the location of all equipment that is not located on the equipment room screens.

3.3.1.1.2 Indicate the location of temperature sensors associated with each temperature-controlled zone (i.e., VAV terminals, fan-coils, single-zone AHUs, etc.) on the floor plan screens.

3.3.1.1.3 Display the space temperature point adjacent to each temperature sensor symbol. Use a distinct line symbol to demarcate each terminal unit zone boundary. Use distinct colors to demarcate each air handling unit zone.

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- 3.3.1.1.4 Mechanical floor plan Drawings will be made available to the Contractor upon request for the purpose of determining zone boundaries. Indicate room numbers as provided by the Owner.
- 3.3.1.1.5 Provide a drawing link from each space temperature sensor symbol and equipment symbol shown on the graphic floor plan screens to each corresponding equipment schematic graphic screen.
- 3.3.1.2 Provide graphic floor plan screens for each mechanical equipment room and a plan screen of the roof. Indicate the location of each item of mechanical equipment. Provide a drawing link from each equipment symbol shown on the graphic plan view screen to each corresponding mechanical system schematic graphic screen.
- 3.3.1.3 If multiple floor plans are necessary to show all areas, provide a graphic building key plan. Use elevation views and/or plan views as necessary to graphically indicate the location of all of the larger scale floor plans. Link graphic building key plan to larger scale partial floor plans. Provide links from each larger scale graphic floor plan screen to the building key plan and to each of the other graphic floor plan screens.
- 3.3.1.4 Provide a graphic site plan with links to and from each building plan.
- 3.3.2 System Schematic Screens: Provide graphic system schematic screen for each HVAC subsystem controlled with each I/O point in the Project appearing on at least one graphic screen. System graphics shall include flow diagrams with status, setpoints, current analog input and output values, operator commands, etc. as applicable. General layout of the system shall be schematically correct. Input/output devices shall be shown in their schematically correct locations. Include appropriate engineering units for each displayed point value. Verbose names (English language descriptors) shall be included for each point on all graphics; this may be accomplished by the use of a pop-up window accessed by selecting the displayed point with the mouse. Indicate all adjustable setpoints on the applicable system schematic graphic screen or, if space does not allow, on a supplemental linked-setpoint screen.
- 3.3.2.1 Provide graphic screens for each air handling system. Indicate outside air temperature and enthalpy, and mode of operation as applicable (i.e., occupied, unoccupied, warm-up, cool-down). Link screens for air handlers to the heating system and cooling system

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graphics. Link screens for supply and exhaust systems if they are not combined onto one screen.

- 3.3.2.2 Provide a graphic screen for each zone. Provide links to graphic system schematic screens of air handling units that serve the corresponding zone.
- 3.3.2.3 Provide a cooling system graphic screen showing all points associated with the chillers, cooling towers and pumps. Indicate outside air dry-bulb temperature and calculated wet-bulb temperature. Link screens for chilled water and condenser water systems if they cannot fit onto one cooling plant graphic screen.
- 3.3.2.4 Provide a heating system graphic screen showing all points associated with the boilers, and pumps. Indicate outside air dry-bulb temperature. Link screens for secondary heating water systems if they cannot fit onto one heating plant graphic screen.
- 3.3.2.5 Link screens for heating and cooling system graphics to utility history reports showing current and monthly electric uses, demands, peak values, and other pertinent values.
- 3.3.3 Bar Chart Screens: On each graphic Bar Chart Screen, provide drawing links to the graphic air handling unit schematic screens.
 - 3.3.3.1 Provide a graphic chilled water valve screen showing the analog output signal of all chilled water valves in a bar chart format, with signals expressed as percentage of fully open valve (percentage of full cooling). Indicate the discharge air temperature and setpoint of each air handling unit, cooling system chilled water supply and return temperatures, and the outside air temperature and humidity on this graphic. Provide drawing links between the graphic cooling plant screen and this graphic screen.
 - 3.3.3.2 Provide a graphic heating water valve screen showing the analog output signal of all air handling unit heating water valves in a bar chart format, with signals expressed as percentage of fully open valve (percentage of full heating). Indicate the temperature of the controlled medium (such as AHU discharge air temperature or zone hot water supply temperature) and the associated setpoint and the outside air temperature and humidity. Provide drawing links between the graphic heating plant screen and this graphic screen.
- 3.3.4 Alarms: Each programmed alarm shall appear on at least one graphic screen. In general, alarms shall be displayed on the

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graphic system schematic screen for the system that the alarm is associated with (for example, chiller alarm shall be shown on graphic cooling system schematic screen). For all graphic screens, display analog values that are in a 'high alarm' condition in a red color, 'low alarm' condition in a blue color. Indicate digital values that are in alarm condition in a red color.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Sections 20 00 00 and 25 00 00 – General Requirements shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Local Supervisory LAN Gateways/Routers.

1.2.2 Provide all interface devices and software to provide an integrated system connecting ANs, ASCs and Gateways to the Owner's Wide Area Network (WAN).

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All materials shall meet or exceed all applicable referenced standards, federal requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 LOCAL SUPERVISORY LAN GATEWAY/ROUTERS

2.2.1 The Supervisory Gateway shall be a microprocessor-based communications device that acts as a gateway/router between the Supervisory LAN CSSs or OWS and the Primary LAN.

2.2.2 The gateway shall perform information translation between the Primary LAN and the Local Supervisory LAN, which is 100 Mbps Ethernet TCP/IP and shall use BACnet over IP.

2.2.3 The gateway shall contain its own microprocessor, RAM, battery, real-time clock, communication ports, and power supply as specified for an AN in Section 25 14 00 – Field Panels. Each gateway/router shall be mounted in a lockable enclosure unless it is a PC that also serves as an OWS.

2.2.4 The gateway/router shall allow centralized overall system supervision, operator interface, management report generation, alarm annunciation, acquisition of trend data, and communication with control units. It shall allow system operators to perform the

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following functions from the CSS, OWSs, and POTs:

- 2.2.4.1 Configure systems.
- 2.2.4.2 Monitor and supervise control of all points.
- 2.2.4.3 Change control setpoints.
- 2.2.4.4 Override input values.
- 2.2.4.5 Override output values.
- 2.2.4.6 Enter programmed start/stop time schedules.
- 2.2.4.7 View and acknowledge alarms and messages.
- 2.2.4.8 Receive, store and display trend logs and management reports.
- 2.2.4.9 Upload/Download programs, databases, etc. as specified.
- 2.2.5 Upon loss of power to the gateway, the battery shall provide for minimum 100 hour backup of all programs and data in RAM.
- 2.2.6 The gateway shall be transparent to control functions and shall not be required to control information routing on the Primary LAN.

3 **EXECUTION**

3.1 PREPARATION

- 3.1.1 Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Subcontractor responsible for the installation of the BAS under the work of Division 25.

3.2 INSTALLATION

- 3.2.1 Installation shall meet or exceed all applicable federal, provincial, and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- 3.2.2 All installation shall be in accordance with manufacturer's published recommendations.
- 3.2.3 Provide all interface devices and software to provide an integrated system.

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- 3.2.4 Closely coordinate with the Owner, or designated representative, to establish IP addresses and communications to assure proper operation of the BAS with Owner's WAN.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Sections 20 00 00 and 25 00 00 – General Requirements shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Refer to the below sequence of operation and associated control schematics for the required number of control loops. Provide all hardware and software necessary to achieve specified control. The sequence of events required for each control loop is described for each system in the control sequence.

1.2.2 Revise the controls shop drawing sequences of operation and create an “As-built or As Functioning Sequence of operation “to be included into the Operations and Maintenance Manuals.

1.2.3 The operators’ workstation to include a Sequence of Operation tab to provide a narrative to the operator regarding equipment / system operation.

2 **PRODUCTS**

Not used.

3 **EXECUTION**

3.1 GENERAL

3.1.1 When motorized equipment is operating, BAS shall totalize runtime in hours for use in maintenance operations.

3.1.2 Where parallel or duplex equipment is provided, BAS shall alternate lead equipment such that runtime is equalized.

3.1.3 Provide adjustable time delay between damper or valve opening and equipment start/stop to avoid operation with a closed system.

3.1.4 Select components to fail safe. Priority in descending order is: life safety, protection of equipment, and comfort.

3.1.5 Schedule operation of systems according to schedules provided by the Owner, and/or optimal start/stop program, and/or Operator keyboard entry.

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- 3.1.6 All low limit thermostats (freezestats), in addition to providing a DI control point, shall be hardwired to the equipment starter to shut down the system upon sensing an air temperature below 2°C (36°F).
- 3.1.7 Shut down fans upon detection (via BAS sensors) of supply or return air temperatures in excess of 67°C (135°F).
- 3.1.8 Co-ordinate the provision of duct mounted smoke detectors by Division 26 - Electrical. Detectors shall be hardwired to the respective fan starter to shut the fan down upon detection of smoke.
- 3.1.9 Co-ordinate fire alarm system fan shutdown where provided via the BAS with Division 26 - Electrical.
- 3.1.10 Fan systems shall not be started if motorized damper end switch indicates that the damper is not fully open. Alarm abnormal status of damper to BAS and start standby system if applicable.
- 3.1.11 Unscheduled shutdown of either the supply or return fan shall result in a system shutdown, and an abnormal status alarm condition at the BAS, and start-up of the standby system if applicable.
- 3.1.12 Static pressure control on all VAV air systems shall be sensed at a position 2/3 downstream of the supply fan. Shut system down if static pressure exceeds 498 Pa (2" w.c.)
- 3.1.13 Airside free cooling control shall be enabled based on enthalpy control.
- 3.1.14 All noted setpoints shall be operator-adjustable, and subject to tuning during system commissioning.
- 3.1.15 Status of motors shall be by current draw unless noted otherwise in the Contract Documents.
- 3.2 **LIFE SAFETY INTERFACE**
- 3.2.1 Division 26 – Electrical shall monitor and control all mechanical systems dedicated to life safety, notably the smoke control systems.
- 3.2.2 The BAS will control all fan shutdowns on fire alarm based on fire alarm zone annunciation via the fire alarm system.

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3.3 HEATING AND COOLING PLANT

3.3.1 System Off:

3.3.1.1 All pumps are off.

3.3.2 Startup:

3.3.2.1 The lead Geothermal Loop pump (GEOP-1/2) shall be started, and the lead Building Primary Loop pump (CP-1/2) shall be started at minimum speed. Pumps shall run for minimum 5 minutes to prevent short cycling.

3.3.3 Geothermal Loop Pump (GEOP-1/2) Control:

3.3.3.1 Geothermal Loop pumps shall be in continuous operation. At all times, either GEOP-1 or GEOP-2 shall be commanded ON. Only if the 'Building Primary Loop' pumps (CP-1 and CP-2) are OFF, will the geothermal circulation pumps turn off.

3.3.3.2 Should the lead pump fail, the lag pump shall start immediately and alarm at the BAS. Lead pumps shall be rotated weekly to ensure even wear on equipment. Alarm shall be initiated if any pump status does not match command after 2 minutes.

3.3.4 Building Primary Loop Pump (CP-1/2) Control:

3.3.4.1 The Building Primary Loop pumps CP-1 and CP-2 shall operate in a parallel pumping configuration with a designated lead and lag pump.

3.3.4.1.1 Should the lead pump fail, the lag pump shall start immediately and alarm at BAS. Lead pumps shall be rotated weekly to ensure even wear on equipment. Alarm shall be initiated if any pump status does not match command after 2 minutes.

3.3.4.2 The Building Primary Loop pressure differential (measured at the 75% of the distance from the mechanical room to the furthest point) shall be maintained by modulating the lead pump speed via VFD. If the lead pump is operating at 95% Speed and differential pressure set point is not met, the lag pump shall be started. Both Building Primary Loop pumps shall modulate together to meet pressure set point. If both pumps are at minimum speed and measured differential pressure is above the set-point the lag pump shall be commanded off.

3.3.4.3 If only lead Building Primary Loop pump is operating at minimum

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speed and differential pressure is above set point. Modulate the bypass valve to maintain set point.

3.3.4.4 If the VFD drive fails or the pressure differential does not match the setpoint longer than 2 minutes. An alarm shall be initiated at the BAS.

3.3.4.5 Initial pressure setpoint is 138kPa (20 psig). Obtain correct operating setpoint from water balancer.

3.3.5 Temperature Control:

3.3.5.1 Under normal operation, the lead Geothermal Loop pump (GEOP-1 or GEOP-2) shall operate to maintain the 'Building Primary Loop' within set maximum and minimum temperatures, as follows:

3.3.5.1.1 If the 'Building Primary Loop Supply Temp' is between 12°C (53.6°F) and 17°C (62.6°F), the pump shall be at minimum speed. Minimum speed shall be set to 30% of total flow at start-up.

3.3.5.1.2 If the 'Building Primary Loop Supply Temp' exceeds 17°C (62.6°F), the pump shall increase speed. Speed shall increase linearly to a maximum speed when 'Building Primary Loop Supply Temp' reaches 27°C (80.6°F) [adjustable] or greater.

3.3.5.1.3 If the 'Building Primary Loop Supply Temp' drops below 12°C (53.6°F), the pump shall increase speed. Speed shall increase linearly to a maximum speed when 'Building Primary Loop Supply Temp' reaches 7°C (44.6°F) [adjustable] or less.

3.4 HORIZONTAL HEAT PUMPS

3.4.1 Each heat pump shall be individually scheduled from the BAS. The operator shall also have the option of scheduling a group of heat pumps together on a single time schedule.

3.4.2 Controls contractor is responsible for interfacing to heat pump thermostats or control boards to allow regular operation. Any relays required are the responsibility of the controls contractor.

3.4.3 Heat pump DDC controller shall cycle the single stage heating and cooling, and the reversing valve to maintain space at the temperature setpoint. Cooling setpoint shall be initially set for 22.8°C (73°F). Cooling command shall be energized above 22.8°C (73°F). Heating command shall be energized below 21.7°C (71°F). Minimum on and off time of 2 minutes for compressor shall be

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programmed to prevent short cycling.

3.4.4 The supply fan shall run continuously when the unit is enabled. Supply fan shall be cycled in the night setback and setup modes as required to maintain the night setback/setup temperature setpoints.

3.4.4.1 When the building is in occupied mode, upon call for heating, cooling or dehumidification at any heat pump the heating and cooling plant shall be started.

3.4.4.2 When the building is in unoccupied mode, if any five (5) thermostat (space temperature) readings are below the unoccupied heating set point or above the unoccupied cooling setpoint, or any one (1) thermostat is reading below 12 °C (54 °F) the heating and cooling plant shall be started.

3.4.4.3 Upon heating, cooling or dehumidification command open the heat pump condenser water control valve and the geothermal exchange system shall be confirmed operational (CP-1 and/or CP-2 enabled, and CEOP-1 or GEOP-2 enabled) before enabling refrigeration circuit for heat pump.

3.4.5 Alarm notification:

3.4.5.1 The heat pump manufacturer shall supply a contact for alarm condition. When active, the BAS shall report that the heat pump is in alarm. This alarm shall activate on compressor failure due to low pressure, high pressure, or condensate high level.

3.4.5.2 Provide status of unit at the BAS

3.4.6 System Shutdown

3.4.6.1 When heating, cooling or dehumidification set points are satisfied the heat pump refrigeration circuit shall be de-activated and then control valve closed. In occupied mode, the supply fan shall continue to operate. In unoccupied mode the supply fan shall be shut off.

3.4.6.2 All building heat pumps shall be disabled on a loss of condenser water flow (Building Primary Loop). This shutdown shall occur before the heat pump factory built controls can lock out the unit.

3.5 WATER TO WATER HEAT PUMPS - HEATING

3.5.1 The WHPs (WHP-1A and WHP-1B) shall operate in parallel with a designated lead and lag WHP. Each with a dedicated WHP

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Primary Pump (CP-3 and CP-4)

- 3.5.1.1 The lead WHP shall be selected based on an adjustable time initially set for the duration of one week, selection for lead WHP shall be based on whichever has lowest totalized run time.
- 3.5.1.2 When the lead WHP or matching WHP Primary Pump fails, the lag WHP shall start and an alarm issued at the BAS.
- 3.5.2 The Heating Loop pumps (GP-1 and GP-2) shall operate in parallel with a designated lead and lag pump.
 - 3.5.2.1 Lead and lag Heating Loop pumps shall be selected based on an adjustable time initially set for the duration of one week, selection for lead Heating Loop pump shall be based on whichever has lowest totalized run time.
- 3.5.3 Unit off:
 - 3.5.3.1 WHP shall be deactivated, corresponding WHP Primary Pump (CP-3/4) shall be deactivated and lead/lag Heating Loop Pump (P-GP-1 and/or GP-2) shall be deactivated.
 - 3.5.3.2 WHP Heating Loop control valve to be closed.
- 3.5.4 Start-up:
 - 3.5.4.1 Upon call for heat at MUA-1 or miscellaneous heating equipment, the WHPs shall be activated for heating mode.
 - 3.5.4.2 Upon call for heating, Building Primary Loop pumps shall be confirmed on. Lead water-to-water heat-pump (WHP-1A/B), matching WHP Primary Pump (CP-3/4), and lead Heating Loop pump (GP-1/2), shall be activated using the below sequence:
 - 3.5.4.2.1 2-way valve on Heating Loop side of lead WHP shall be commanded open.
 - 3.5.4.2.2 Corresponding WHP Primary Pump (CP-3/4) and lead Heating Loop Pump (GP-1/2) shall be started.
 - 3.5.4.2.3 Upon confirmation of flow, measured by differential pressure sensors on both Building Primary Loop side and Heating Loop side of WHP, the WHP shall be started.
 - 3.5.4.2.4 WHP controller shall stage compressors to maintain Heating Loop supply setpoint.

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3.5.4.2.5 If lead WHP is operating at full capacity and main Heating Loop supply temperature set-point is not met, lag WHP and associated pumps shall be started following same procedure as lead WHP. If only lead WHP is in operation, only lead Heating Loop pump shall be running. If both WHPs are in operation, both Heating Loop pumps shall be running.

3.5.4.2.6 If both WHPs are operating at minimum capacity and the main Heating Loop supply temperature is maintained, the lag WHP and corresponding pumps shall be deactivated.

3.6 WATER TO WATER HEAT PUMPS - COOLING

3.6.1 The WHP (WHP-2) shall operate with a dedicated WHP Primary Pump (CP-5)

3.6.2 The Cooling Loop pumps (GP-3 and GP-4) shall operate in parallel with a designated lead and lag pump.

3.6.2.1 Lead and lag Cooling Loop pumps shall be selected based on an adjustable time initially set for the duration of one week, selection for lead Heating Loop pump shall be based on whichever has lowest totalized run time.

3.6.3 Unit off:

3.6.3.1 WHP shall be deactivated, corresponding WHP Primary Pump (CP-5) shall be deactivated and lead/lag Cooling Loop Pump (P-GP-3 and/or GP-4) shall be deactivated.

3.6.3.2 WHP Cooling Loop control valve to be closed.

3.6.4 Start-up:

3.6.4.1 Upon call for cooling at MUA-1, the WHP shall be activated for cooling mode.

3.6.4.2 Upon call for cooling, Building Primary Loop pumps shall be confirmed on. Water-to-water heat-pump (WHP-2), matching WHP Primary Pump (CP-5), and lead Cooling Loop pump (GP-3/4), shall be activated using the below sequence:

3.6.4.2.1 2-way valve on Cooling Loop side of WHP shall be commanded open.

3.6.4.2.2 Corresponding WHP Primary Pump (CP-5) and lead Cooling Loop Pump (GP-3/4) shall be started.

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3.6.4.2.3 Upon confirmation of flow, measured by differential pressure sensors on both Building Primary Loop side and Cooling Loop side of WHP, the WHP shall be started.

3.6.4.2.4 WHP controller shall stage compressors to maintain Cooling Loop supply setpoint.

3.7 ENERGY RECOVERY MAKE-UP AIR HANDLING UNIT

3.7.1 The make-up air unit supplies 100% conditioned outdoor air to the horizontal heat pumps. The supply air temperature setpoint shall be 12.8°C (55°F) (adjustable).

3.7.2 Unit off:

3.7.2.1 This mode is initiated by loss of supply or return fan status or by time schedule from BAS.

3.7.2.2 Outdoor air and exhaust air dampers are closed, supply and return fans are off.

3.7.3 Start-up:

3.7.3.1 Start-up is initiated by time schedule from the BAS.

3.7.3.2 Outdoor air and exhaust dampers open to preset minimum position. Supply and return fans start.

3.7.4 Temperature Control:

3.7.4.1 When supply air temperature is below setpoint, initially set at 21.1°C (70°F), for min. 5 min., the lead glycol heating pump shall be activated. The glycol heating valve shall be enabled and modulated to maintain setpoint. Monitor glycol temperatures in and out of the coil. Rotate the lead glycol heating pump monthly. The lag glycol heating pump shall be started on a failure of the lead pump.

3.7.4.2 When supply air temperature is above setpoint for min. 5 min., the cooling coil valve shall be enabled and modulated to maintain setpoint.

3.7.5 Humidity Control:

3.7.5.1.1 Exhaust air humidity setpoint is reset based on outdoor air temperature:

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- 3.7.5.1.2 OAT < -5°C (23°F), Setpoint = 30 %RH
- 3.7.5.1.3 OAT > 32.2°C (90°F), Setpoint = 50 %RH
- 3.7.5.1.4 -5°C (23°F) < OAT < 32.2°C (90°F), Setpoint is linear between above values.
- 3.7.5.2 Humidifier is enabled and modulated to maintain return air humidity when return air humidity is below setpoint and the outside air temperature is below 12.8°C (55°F).
- 3.7.5.3 Manufacturer's safety devices (high limit, air proving switch) shall be wired to humidifier to prevent unsafe conditions. The BAS shall monitor duct relative humidity downstream of the humidifier grid to ensure that the supply air humidity level never exceeds 90% RH. Approaching this limit, the BAS shall modulate back the demand signal to the humidifier.
- 3.7.6 Enthalpy Wheel Control
 - 3.7.6.1 Enthalpy wheel shall operate in one of 3 modes: Heating, Cooling, or Economizer.
 - 3.7.6.2 Frost Protection:
 - 3.7.6.2.1 Frost protection of the enthalpy wheel is required when the entering outdoor ambient dry bulb temperature is below the frost threshold. Frost threshold is defined as the point on a psychrometric chart at which a straight line drawn between the indoor conditions and the outdoor conditions first crosses the saturation point.
 - 3.7.6.2.2 The following table simplifies the psychrometric calculations for typical conditions found. A winter outdoor %RH of 85% is assumed. Outdoor dry bulb frost threshold based on return temperature & relative humidity:

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3.7.6.2.3

Ret %RH	Ret = 20°C	Ret = 21°C	Ret = 22°C	Ret = 24°C	Ret = 26°C
20	-27	-26	-25	-24	-22
30	-19	-19	-19	-18	-16
40	-16	-15	-14	-13	-12
50	-12	-11	-10	-9	-8
60	-9	-8	-7	-6	-4

- 3.7.6.2.4 Use the above table to set the frost protection threshold. Should the ambient dry bulb drop below the frost threshold, enable frost protection.
- 3.7.6.2.5 For simplicity, use the next lower case scenario when the return temperature value falls between the above conditions.
- 3.7.6.2.6 For example, if the return air temperature is 21.5°C, use the values from the 21°C table. Use a linear calculation when return air humidity falls between the above values. For example, at 35%RH and 22 °C return temperature, the outdoor threshold shall be -16.4°C (1/2 way between -13.9 and -18.9).
- 3.7.6.2.7 Frost protection shall be provided by slowing down the enthalpy wheel whenever outdoor air temperature is below the frost threshold.
- 3.7.7 Shutdown:
- 3.7.7.1 Supply and exhaust fans are off, dampers are closed.
- 3.7.7.2 Alarm if the closed position end switch of the outdoor air damper did not make after two (2) minutes the unit is shut down.
- 3.7.8 If the freezestat is activated, alarm at the BAS start WHPs for heating mode and modulate the HCS/R 3-way valve to fully open position and activate call for heating.
- 3.7.9 Monitor pressure drop across air filters.

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3.8 DOMESTIC HOT WATER BOILER PLANTS

- 3.8.1 Refer to domestic hot water flow diagrams and for additional details.
- 3.8.2 Boiler shall initiate to maintain domestic hot water temperature at setpoint of 60.0°C (140°F).
- 3.8.3 Each boiler control panel shall control capacity of each boiler to maintain domestic hot water temperature at setpoint of 60.0°C (140°F).
- 3.8.4 To enable a boiler, start respective primary boiler pump, prove flow via differential pressure sensor, and then enable boiler. Boiler controls shall maintain temperature setpoint.
- 3.8.5 Minimum on and off times of 3 minutes shall prevent short cycling of boilers.
- 3.8.6 On system off, boilers shall be disabled. Circulators shall run for 5 minutes to dissipate residual heat from the boilers.
- 3.8.7 Should any pump or boiler status not match command after 2 minutes, initiate alarm at BAS.

3.9 FORCE FLOW HEATERS

- 3.9.1 Terminal heater supply fan shall run continuously when the unit is enabled. Modulate the heating water valve to maintain the required minimum space temperature setpoint.

3.10 RADIANT PANEL

- 3.10.1 Modulate heating control valve to maintain space temperature setpoint of 22°C (72°F).

3.11 WATER DETECTION SYSTEMS

- 3.11.1 Monitor dry contacts at local water detection alarm panels.
- 3.11.2 Alarm via BAS if water is detected and close associated solenoid valves. The solenoid valve shall remain in alarm until user manually resets the alarm on the BAS.
- 3.11.3 BAS shall notify Operations.
- 3.11.4 Provide BAS graphic of floor plan showing location of alarm and

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description of source, e.g. "Hot Water Tank Drain Pan", etc.

- 3.11.5 Provide points list for water leak detection system with corresponding solenoid valves (open/closed).
- 3.11.6 Program control panel to have regular self-verification of solenoid valve function.
- 3.11.7 Domestic Hot Water Heaters:
 - 3.11.7.1 When water is detected the associated DHWR pump shall shut down and the associated domestic cold water solenoid valve shall close.
- 3.11.8 Drip Pans:
 - 3.11.8.1 Locate leak sensor next to near drain opening.
- 3.12 FIRE ALARM SYSTEM
- 3.12.1 Monitor the fire alarm control panel for alarm and trouble.
- 3.13 HEAT TRACE MONITORING SYSTEM
- 3.13.1 Monitor all heat trace status.
- 3.13.2 If the individual heat trace status is off and the outdoor temperature is below 4°C prompt for alarm.
- 3.14 MISCELLANEOUS CONTROL POINTS
- 3.14.1 Monitor the following additional points via the BAS.

MISCELLANEOUS CONTROL POINTS			
DESCRIPTION	LOCATION	TYPE	REMARKS
Water Check Meters	Meter Panel	DI	Pulse Counter for Consumption (2x)
BTU Check Meters	Meter Panel	DI	Pulse Counter for Consumption (2x)
Electricity Meter	Electrical Meter	DI	Each Meter

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END OF SECTION

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SECTION 26 09 00 INSTRUMENTATION AND CONTROL FOR ELECTRICAL SYSTEMS

Section 26 09 23	Lighting Control Devices
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SECTION 26 20 00 LOW-VOLTAGE ELECTRICAL TRANSMISSION

- Section 26 22 13 Dry Type Transformers Up to 600V Primary
- Section 26 24 02 Service Entrance & Utility Requirements
- Section 26 24 13 Switchboards
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- Section 26 28 16.01 Moulded Case Circuit Breakers
- Section 26 28 18 Ground Fault Equipment Protection
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SECTION 26 30 00 FACILITY ELECTRICAL POWER GENERATING EQUIPMENT

- Section 26 36 23 Automatic Load Transfer Equipment

SECTION 26 40 00 ELECTRICAL PROTECTION

- Section 26 43 13 Surge Protective Devices

SECTION 26 50 00 LIGHTING

- Section 26 50 00 Lighting
- Section 26 52 01 Unit Equipment for Emergency Lighting
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SECTION 26 90 00 Manufacturers

- Section 26 90 00 List of Acceptable Manufacturer

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SECTION 48 00 00 Solar

Section 48 14 00 Solar Energy Electrical Power Generation

APPENDICES

Appendix A Panel Schedules

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1 **GENERAL**

1.1 GENERAL

1.1.1 This Section covers items common to Sections of Division 26. This section supplements requirements of Division 1.

1.1.2 Comply with General and Supplementary Conditions of Contract.

1.1.3 Conditions and Division 01 General Requirements. This Section covers items common to Sections of Division 26.

1.1.4 Where conflict occurs between Codes, Specification and Drawings, plan and riser, the maximum condition is to govern, and the Tender is to be based on whichever indicates the greater cost.

1.1.5 Provide all materials, equipment, labor and services to complete the installation, wiring, testing and commissioning of the complete and functioning electrical systems, including but not limited to the scope of work specified in this section.

1.2 INTENT

1.2.1 The General Requirements apply to all Sections of this Division.

1.2.2 The extent of the work shall comprise the whole management, programming, labour and materials required to form a complete installation, together with such tests, adjustments and commissioning as prescribed in subsequent clauses and otherwise as may be required in order to provide an effective working installation to the satisfaction of the Engineer.

1.2.3 This specification covers the design of details, supply, installation and testing of all necessary equipment required for the complete Electrical Engineering Services as described in the Contract Documents and incorporates standard descriptions for equipment and the installation to be provided under this Contract. The clauses shall be read in conjunction with all other Contract Documents.

1.2.4 Provide all items, articles, materials, operations and methods listed, mentioned and scheduled in the contract documents. Include all labour, equipment, tools, scaffolds and other incidentals necessary and required for the complete installation.

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1.2.5 Consider the specifications as an integral part of the drawings which accompany them. Do not use the drawings or the specifications alone. Consider any item or subject omitted from one, mentioned or reasonably implied in the other, as properly and sufficiently specified and provides same under the work of this division.

1.2.6 Each Contractor is considered to be an expert in their field.

1.3 WORK INCLUDED

1.3.1 Work to be done under this section to include furnishing of labour, materials and equipment required for installation, testing and putting into proper operation complete Electrical systems as shown, as specified, as intended, and as otherwise required. Complete systems to be left ready for continuous and efficient satisfactory operation.

1.4 CODES, PERMITS, FEEDS, AND INSPECTION

1.4.1 All work shall meet or exceed the latest requirements of the Ontario Electrical Safety Code and its supplement, local inspection bulletins, and all authorities having jurisdiction.

1.4.2 Obtain all permits and arrange for inspection of all work and pay all fees in this regard. On completion of the work, deliver the final unconditional "Certificate of Approval of the Electrical Inspection Authority" to the Consultant.

1.4.3 Before proceeding with any work, submit the required number of sets of plans and specifications to the Electrical Inspection Authority for approval and pay all costs in this regard. Bring any additional requirements or changes required by the Electrical Inspection Authority to the attention of the Consultant immediately.

1.4.4 It is hereby agreed that all requirements have been examined and checked with the Electrical Inspection Authority and CSA, and a complete installation in accordance with these requirements will be provided at the Tender Price.

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- 1.4.5 Keep a permanent record of each inspection made by the Electrical Inspection Authority showing the date, inspector's name, scope of the inspection, and statement of special decisions or permissions granted. Make these records available to the Consultant at any time, and turn them over to them after the completion of the work.
- 1.4.6 Provide partial inspection and approval reports as required to suit phasing and partial occupancy requirements.
- 1.4.7 Abbreviations for electrical terms shall be as per CSA Z85-1983.
- 1.5 SCOPE OF WORK
 - 1.5.1 The scope of the contract works shall include but not limited to the supply, delivery, off-loading, erection, setting-to-work, testing and commissioning and handing over of the electrical building services installation outlined below and described in more detail elsewhere in the specification and indicated on the drawings all in accordance with the contract documentation.
 - 1.5.2 The Contractor shall be responsible to review and fully understand the specification and the scope of work. Furthermore, the Contractor shall be responsible to provide all conduit, wiring, power supply, accessories and supplementary component, necessary for the safe and proper operation of the various systems.
 - 1.5.3 The Contractor shall be responsible as follows:
 - 1.5.3.1 Visit the site to familiarize themselves with the scope of work.
 - 1.5.3.2 Preparation of shop drawings and obtaining approval from the various authorities prior to execution of work.
 - 1.5.3.3 Obtaining all materials and work approval during execution and on completion of works.
 - 1.5.3.4 All costs and charges required by the various local authorities and any related to the connection of permanent power supply and kWh meters including the provision of the tenants kWh meters shall be included in the scope of work except the power connection charges which shall be paid by the Client.
 - 1.5.4 High Voltage Installation:

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- 1.5.4.1 Liaise and coordinate with the Local Authority Distribution Company and provide all assistance to facilitate the installation of all Local Authority Distribution Company supplied, installed and commissioned Transformers.
- 1.5.4.2 Provide transformer grounding system.
- 1.5.4.3 Include for lay in duct bank and termination of the interconnecting cabling from the secondary side of the transformers to the LV switchgear.
- 1.5.5 Low Voltage Installation:
 - 1.5.5.1 Supply and installation of all switchboards, distribution panels, and panelboards, and power factor correction as identified in Construction Documents.
 - 1.5.5.2 Automatic Transfer Switches (ATS), including outgoing LV cabling to essential and life safety services, and integral phase failure relays.
 - 1.5.5.3 Busbars with fully rated neutral and earth integral and MCCB tap off units where indicated.
 - 1.5.5.4 Main and sub-main distribution cables and system wiring.
 - 1.5.5.5 Emergency power off system and trip facilities including battery-tripping units.
 - 1.5.5.6 ACB/MCCB protection settings.
 - 1.5.5.7 All containment systems required to facilitate the above services.
 - 1.5.5.8 Leak detection system;
 - 1.5.5.9 All associated noise and vibration control measures including attenuators and anti-vibration mounts;
- 1.5.6 Grounding and Bonding:
 - 1.5.6.1 Supply and installation of all main and supplementary earth bars in all plant rooms and risers as indicated in the tender drawings.
 - 1.5.6.2 Equipment bonding.
 - 1.5.6.3 Circuit protective conductors.

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- 1.5.6.4 Cableways and interconnecting cabling for the above.
- 1.5.7 Lighting Installation:
 - 1.5.7.1 The Electrical Contractor shall be responsible for the supply and installation of all luminaires as indicated on the tender drawings and described in this specification. The complete lighting installation shall include but not be limited to:
 - 1.5.7.1.1 All luminaires as specified on the drawings and in the contract documentation, which shall include both Electrical Consultant specification and specialist lighting designer's specifications.
 - 1.5.7.1.2 All luminaire fixings.
 - 1.5.7.1.3 Power supplies, cabling and containment.
 - 1.5.7.1.4 Lighting control system as described and detailed on the drawings and later in this specification.
 - 1.5.8 Small Power Installation:
 - 1.5.8.1 The Electrical Contractor shall be responsible for the supply and installation of the small power services as detailed on the tender drawings. This shall include but not be limited to the following:
 - 1.5.8.1.1 General purpose socket outlets in all areas.
 - 1.5.8.1.2 Single phase and three phase power points for laboratory equipment as indicated on the tender drawings.
 - 1.5.8.1.3 Power supplies to power assisted doors.
 - 1.5.8.1.4 Power supplies to automatic openable windows.
 - 1.5.8.1.5 Power supplies entrance doors.
 - 1.5.8.1.6 Power supplies to motorised dampers.
 - 1.5.8.1.7 Power supplies to fan coil units.
 - 1.5.8.1.8 Power supplies to Kitchen equipment.
 - 1.5.8.1.9 Power supplies to meeting room equipment.
 - 1.5.8.1.10 Power supplies to Public Address System.
 - 1.5.8.1.11 Advertisement power and control system.

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- 1.5.8.1.12 Supply and installation of all sub main and final circuit distribution boards.
- 1.5.8.1.13 All combination of outlets, switch units, fused connection units, flex outlets, commando sockets, isolators and junction points for specialist equipment's as detailed on the tender drawings.
- 1.5.8.1.14 All cable tails to service distribution points as detailed.
- 1.5.8.1.15 Wiring and raceways to facilitate the above installation.
- 1.5.8.2 Earth electrodes
- 1.5.8.3 Surge protection devices to all sub main and final circuit distribution panels at roof level serving equipment susceptible to lightning strike.
- 1.5.8.4 Surge protection devices to all Main Switchboard and Distribution Panels.
- 1.6 RELATION TO WORK OF OTHER DIVISIONS
 - 1.6.1 Examine the Work of other Divisions upon which the Work of this Division depends for proper completion. Contractor shall report any defect or variance to the Engineer. Do not commence work under this Division until such defects have been resolved.
 - 1.6.2 Coordinate the work of the Electrical Division with the Work of the other Divisions in such a manner that there is no interference and conflicts. In areas where conduits and equipment called for in the Electrical Division will be installed in conjunction with pipes, ductwork and equipment called for in other Divisions, Contractor shall coordinate the work to ensure proper installation, clearances, access, and the best use of the space.
 - 1.6.3 Coordinate with other Divisions excavation, backfilling, form work, shoring and concrete work for maintenance holes, cable pits, equipment bases, concrete pads, earth wells and pits, lighting pole bases and all other work of this Division, to be carried out under the appropriate Divisions of this Specification.
 - 1.6.4 Verify in the field all dimensions, locations and clearances affecting the work of this Division.
- 1.7 CONTRACT DOCUMENTS
 - 1.7.1 The drawings for the electrical work are performance drawings and

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diagrammatic, intended to convey the scope of the work and indicate general arrangement and approximate location of apparatus, fixtures and conduit runs. The drawings do not intend to show architectural and structural details.

- 1.7.2 Do not scale drawings. Obtain information involving accurate dimensions shown on architectural and structural drawings, or by site measurements. Consult general construction drawings, as well as detail drawings to become familiar with all conditions affecting work, and verify spaces in which the work will be installed.
- 1.7.3 Make, at no additional cost, any changes or additions to materials and/or equipment necessary to accommodate structural conditions (runs around beams, columns, etc.).
- 1.7.4 Alter, at no additional cost, the location of materials and/or equipment as directed, provided that the changes are made before installation and any such outlet is not relocated in excess of 3m (10') in any direction.
- 1.7.5 Install all ceiling mounted components (luminaires, speakers, bells, etc.) in accordance with reflected ceiling drawings, approved by the Consultant.
- 1.7.6 Leave space clear and install all work to accommodate future materials and/or equipment as indicated, and to accommodate equipment and/or material supplied by another division of work or contract. Verify spaces in which work is to be installed. Install all conduit runs, etc., to maintain headroom and clearances and to conserve space in shafts and ceiling spaces.
- 1.7.7 Confirm on the site the exact location of outlets for equipment supplied under other divisions of work or contracts.
- 1.7.8 Confer with all trades installing equipment which may affect the work of this division, and arrange equipment in proper relation to equipment installed under all divisions of the contract.
- 1.7.9 Timeously furnish all items to be built in, complete with all pertinent information, commensurate with the progress of the work.
- 1.7.10 Store materials neatly and out of the way and clean up daily all refuse caused by the work.
- 1.7.11 Relocate equipment and/or material installed, but not coordinated with the work of other divisions, as directed by the Consultant at no

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extra cost.

1.7.12 Where discrepancies are found within the Contract Documents, the maximum conditions will govern.

2 **PRODUCTS**

2.1 MATERIALS

2.1.1 Contactor shall arrange and format the submittals for the materials and related drawings to the Engineer for approval and to include the necessary details as requested by the Engineer.

2.1.2 The contractor shall specify items/materials from the list of approved suppliers/manufacturers or equal and approved. However this shall be limited to a single alternative and should this be rejected the contractor is obliged to revert to the list of approved suppliers/manufacturers

2.1.3 Materials and equipment shall be:

2.1.3.1 New and free of all defects,

2.1.3.2 Designed, manufactured and tested in accordance with the latest issues of all applicable CSA and other applicable industry standards,

2.1.3.3 Certified by CSA or acceptable to the authorities having jurisdiction, including special inspection if required.

2.1.3.4 All electrical equipment shall be designed for operating in a 50°C ambient temperature with 100% relative humidity. Copies of test certificates shall be provided prior to ordering equipment.

2.1.3.5 Equipment or material used in hazardous classified areas such as battery rooms shall be certified for use in such locations from recognized authorities such as Bassefd, PTB etc.

2.1.3.6 Provide samples properly labeled of each material specified in this specification or requested by the Engineer. Such samples shall be submitted to the Engineer for their approval at their offices or elsewhere as directed with all parts left loose, so that they may be taken apart for internal inspection by hand without the necessity of using spanners, screw drivers or wrenches.

2.1.3.7 Where more than one of any item is required, all shall be of the same type and manufacture.

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2.1.3.8 The products of the specified manufacturers are acceptable only when these products comply with or are modified as necessary to comply with the requirements of the contract documents.

2.1.3.9 Items of equipment or material, which are not specifically defined herein, shall conform to the general standard of quality established herein.

3 **EXECUTION**

3.1 GENERAL

3.1.1 Contractor shall submit detailed method statement for installation of each system to the engineer approval. Execution of work shall be carried out strictly in accordance with the engineer approved shop drawings and method statements.

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3.1.3 All systems shall be segregated from each other. Contractor shall provide narrative and schematics on methods and procedures for system segregation. Narrative shall include bundling, separation, color coding, and installation of each system installed by the electrical Contractor. Narrative shall be approved by the Engineer and owner prior to commencement of work.

3.2 ACCESS PANELS AND DOORS

3.2.1 Provide all access panels and/or doors to facilitate the maintenance and/or servicing of all electrical equipment installed in concealed spaces.

3.2.2 Indicate on the "as-built" drawings the location of these panels and doors.

3.2.3 Doors and panels in fire rated enclosures shall be ULC listed sandwich doors and shall have the same rating as the enclosure.

3.2.3.1 Doors shall have concealed hinges and screwdriver operated lock. Doors shall be as follows:

3.2.3.2 Concrete Block and Drywall: 12 gauge prime painted steel door.

3.2.3.3 Plaster and Acoustic Tile: recessed dish shaped door to accept ceiling tile or welded metal lath for plaster.

3.2.4 All access doors and locations shall be to the Consultant's approval.

3.3 CARE, OPERATION AND START-UP

3.3.1 Instruct Consultant and operating personnel in the operation, care and maintenance of equipment.

3.3.2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components.

3.3.3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with all aspects of its care and operation.

3.4 COMPLETION

3.4.1 Clean all fixtures and equipment. Polish all plated surfaces.

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- 3.4.2 Set all relays to operating condition.
- 3.4.3 Remove all temporary protection and covers.
- 3.4.4 Vacuum clean the inside of switchgear, panelboards, motor control centre, and fire alarm control panel and annunciators. Ensure that they are free from debris and dust.
- 3.4.5 Change all lamps. All lamps are to be new at time of system acceptance.
- 3.4.6 Leave electrical work in as-new working order.
- 3.5 CONSTRUCTION AND INTERFERENCE DRAWINGS
- 3.5.1 Prepare fully dimensioned drawings showing sleeves and openings through structure. Indicate locations and weights on all load points.
- 3.5.2 Prepare drawings of pits, curbs, sills, equipment bases, anchors, inertia slabs, etc.
- 3.5.3 Prepare fully dimensioned construction drawings of Products and services in electrical rooms, service and ceiling spaces, and all other critical locations. Co-ordinate the Work with all other Divisions. Base drawings on reviewed shop drawings and indicate all details pertaining to access, clearances, cleanouts, sleeves, electrical connections, drain locations and elevations of pipes, ducts and conduits.
- 3.5.4 Submit construction/interference drawings prior to commencement of work.
- 3.5.5 Provide AutoCAD files indicating all electrical equipment mounted on or above the ceilings or at ceiling level in areas without ceilings to the mechanical contractor for preparation of interference drawings. Items to be coordinated include all electrical equipment that may interfere with installation of the work of other trades including outlet box locations, hangers and supports, cable trays, luminaires, etc. Indicate depths of luminaires or other recessed electrical equipment to assist in the coordination of services
- 3.5.6 Submit drawings coordinated and approved by all trades, to the Consultant and include one complete set in each operating and maintenance manual.
- 3.5.7 Construction drawings are prepared for construction and record

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purposes only and are not part of the contract documents or shop drawings.

3.6 CUTTING AND PATCHING

- 3.6.1 Do all cutting and patching required for the installation of new equipment and surface restoration after the removal of existing equipment. Work will be carried out by others at this Contractor's cost. For patching use materials equal to those comprising the surrounding area.
- 3.6.2 Inform other Division Contractors in sufficient time with regard to required openings. Where this requirement is not met, bear the cost of all cutting and patching.
- 3.6.3 In existing work and work already finished, cutting and patching will be carried out by the General Contractor at the Electrical Contractors' expense.
- 3.6.4 Be aware of fire rated partitions, minimize the area affected by the work, and return all surfaces to a condition encountered before the work. Acceptance of the finished work is at the sole discretion of the Consultant.
- 3.6.5 Painting of finished surfaces will be by the General Contractor to match adjacent surfaces.

3.7 DEMOLITION

- 3.7.1 Make safe and disconnect all power and systems, as and when, and to the extent required to facilitate with the demolition.
- 3.7.2 Ensure that all electrical, life safety services, and services for existing equipment, in areas outside the areas of this work, that are required to remain in service, shall do so.
- 3.7.3 Relocate any electrical feeders or equipment that are required to remain in service, that are secured to existing walls, floors or ceilings to be demolished or that are buried and required to be excavated for new work.
- 3.7.4 Remove and replace any electrical equipment on walls or ceilings that will be demolished and rebuilt.
- 3.7.5 When deleting and/or making safe existing electrical work, ensure that it includes all wiring back to the associated panelboard or control panel.

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- 3.7.6 Disconnect and remove existing light fixtures, devices, outlets, etc. which are not to be reused. Such items shall be cartoned and turned over to the Owner at a place designated by the Owner. Cut back and cap unused raceway and outlets and remove unused wiring back to panelboard in an approved manner.
- 3.7.7 Ensure that all existing equipment which is to be reused and/or relocated is thoroughly inspected and refurbished to ensure correct operation when put back into service.
- 3.7.8 All existing electrical equipment which is no longer required shall be removed and disposed of, off site.
- 3.7.9 Be responsible and pay for any damage to the base building incurred by work of this Division, or repair to the satisfaction of the Consultant.
- 3.7.10 Carry out the work with a minimum of noise, dust and disturbance.
- 3.7.11 Provide tools and clean up equipment. Obtain the Owner's permission for the use of electrical, plumbing or drainage outlets.
- 3.7.12 Provide daily clean-up and proper disposal of debris generated by daily operations. On completion of the work, all tools, surplus materials and waste materials shall be removed and the premises left in a clean, perfect condition.
- 3.8 EQUIPMENT SUPPORTS, ANCHORS AND HANGERS
- 3.8.1 Provide all supports required for the erection and support of the electrical work.
- 3.8.2 Support all suspended equipment from the bottom.
- 3.8.3 Provide all lintels where required.
- 3.8.4 Suspend all hangers directly from the structure using approved inserts or beam clamps.
- 3.8.5 Do not use pipe hooks or perforated straps.
- 3.8.6 Hangers shall be spaced such that there is a hanger within 610mm (24") of every bend and that the maximum spacing does not exceed the limits as per the local standard requirement.
- 3.8.7 Vertical pipes shall be supported at each floor slab and at the top and bottom of each riser.

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3.8.8 Support all conduit or cable at equipment mounted on spring isolators, with spring hangers for at least 4572mm (15').

3.8.9 Do not support any conduits from ductwork, pipes etc.

3.9 EXCAVATION AND BACKFILL

3.9.1 All excavation and backfilling will be carried out by this Contractor.

3.9.2 Conform to the performance standards of Division 02.

3.9.3 All rough excavation, i.e., excavation to within 152mm (6") of final elevation, will be done by Division 02.

3.9.4 All final backfilling, i.e., backfilling from a location 305mm (12") above the electrical equipment or service, to grade, will be done by Division 02.

3.9.5 Do all final excavation, i.e., excavation of the last 152mm (6") to final elevation, and all initial backfilling, i.e., backfilling of the first 305mm (12") above the electrical equipment or service.

3.9.6 Conform to the performance standards of Division 02 with respect to all excavation and backfilling.

3.9.7 Obtain approval from the Consultant before backfilling.

3.9.8 After backfilling and compaction, return the surface to match the original condition, or as directed by the Consultant.

3.10 EXPANSION JOINTS AND LOOPS

3.10.1 Supply and install expansion joints or loops in conduits crossing expansion joints in the structure without imposing undue stress on structure, apparatus or conduit.

3.11 EXISTING CONDITIONS

3.11.1 Visit the site and examine the existing conditions affecting the work of this Division.

3.11.2 No claim for extra payment shall be made for extra work made necessary by circumstances encountered due to conditions which were visible upon, or reasonably inferable from an examination of the site prior to submission of the Bid.

3.12 EXPEDITING

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- 3.12.1 Continuously check and expedite delivery of equipment and materials.
- 3.12.2 As required, inspect equipment, etc. at the source of manufacture.
- 3.12.3 Continuously check and expedite the flow of necessary information to and from all parties involved.
- 3.12.4 Immediately inform the Construction Manager and the Consultant where information is required from them, and attend to any request for information, details, dimensions, etc. from them.

3.13 FIELD QUALITY CONTROL

- 3.13.1 Carefully check each piece of apparatus for completeness of connections, accessories, wiring and controls and place in operation, test and adjust.
- 3.13.2 Obtain written permission to start and test permanent equipment and systems.
- 3.13.3 Operate each piece of equipment, including motors and controls, continuously for minimum 2 hours in the presence of the Engineer.
- 3.13.4 Correct defects; repeat tests until no defects are disclosed; leave equipment clean and ready for use.
- 3.13.5 After completion of initial trial test, execute Reliability Tests for plant and equipment. Give Engineer 7 days' notice before commencing tests.
- 3.13.6 Each reliability test shall last for 30 consecutive days during which time the whole of the plant being tested shall operate continuously without adjustment or repair.
- 3.13.7 Repeat reliability test after repairs and adjustments (other than normal running adjustments) have been carried out, until system runs as intended.
- 3.13.8 Run systems under full summer and winter load conditions.
- 3.13.9 The Electrical Contractor is responsible for the following tests:
 - 3.13.9.1 Power distribution system including phasing, voltage, grounding and load balancing.
 - 3.13.9.2 Circuits originating from branch distribution panels.

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- 3.13.9.3 Lighting and its control.
- 3.13.9.4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
- 3.13.9.5 Systems: fire alarm system, communications.
- 3.13.9.6 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- 3.13.9.7 Insulation resistance testing.
- 3.13.9.8 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
- 3.13.9.9 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
- 3.13.9.10 Check resistance to ground before energizing.
- 3.13.9.11 Any tests and commissioning work identified in the individual sections of this Electrical Specifications.
- 3.13.10 Carry out tests in presence of Consultant.
- 3.13.11 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- 3.13.12 Submit test results for Consultant's review.
- 3.14 FIELD REVIEW
- 3.14.1 The Consultants will make periodic visits to the site during construction to ascertain reasonable conformity to plans and specifications. The Consultant is not responsible for quality control. The Contractor shall maintain their own quality control and will be responsible for the execution of their work in conformity with the contract documents and the requirements of the Authorities.
- 3.14.2 The Owner and Consultant shall have access to the site at all times for periodic inspections. Maintain a complete set of contract documents on site for field reference by the Consultant.
- 3.14.3 Provide all gauges, instruments, and other equipment necessary for field review by the Consultant.

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3.14.4 Application for final review will be considered when the Work has been completed and written declarations submitted that all commissioning, adjustment, set up and documentation is complete. Final review will be completed when:

3.14.4.1 All reported deficiencies have been corrected.

3.14.4.2 All systems have been tested, commissioned and are operational.

3.14.4.3 The Owner has been instructed in the operation and maintenance of all equipment.

3.14.4.4 All reports have been submitted and reviewed.

3.14.4.5 All instruction manuals have been submitted and reviewed.

3.14.4.6 All directories and nameplates are in place.

3.14.4.7 Cleaning up is finished in all respects.

3.14.5 All spare parts and replacement parts specified have been provided.

3.14.6 All record drawings have been submitted and reviewed.

3.15 FINISHES

3.15.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

3.15.2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

3.15.3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

3.16 FIRE RATING

3.16.1 All feeder conduits for the following systems shall be 2 (two) hours fire rated MI cable:

3.16.1.1 Emergency Distribution and Lighting Panels

3.16.1.2 All life safety systems

3.17 FIRE SEALS

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3.17.1 Where cables, bus ducts, cable tray, or conduits pass through non-fire rated floors, walls or roof, provide internal and external sealing thereto.

3.17.2 For non-fire rated locations, sealant shall be silicone.

3.17.3 For fire rated locations, the sealant shall be fire stop and shall meet the requirements of authorities and to U.L, and CSA standards with regard to the type of assembly and fire separation.

3.18 GROUNDING AND BONDING

3.18.1 The whole of the installation covered by this specification shall be efficiently bonded back to the main switchboards through the metal sheathing of cables or thru a separate earthing conductor as indicated on drawings. The steel conduit, the trunking system and earth wires, all in accordance with the OESC and IEEE recommended practices. All prices shall be inclusive of the cost of this bonding.

3.18.2 All grounding installations, size of grounding conductors and bonding shall be in accordance with the OESC.

3.18.3 The grounding continuity of each metal sheathed cable shall be maintained by efficient bonding between the cable sheath, the gland and the metal case of switchgear or other metal-clad accessory or appliance at which the cable terminates.

3.18.4 All wires and cables shall be protected against mechanical stresses and corrosion.

3.18.5 All joints between wires and earthing metalwork shall be mechanically sound before soldering.

3.18.6 Where separate pieces of apparatus connected to different phase are, of necessity erected or positioned less than two meters apart, an equipotential bonding strip 2.5mm x 35mm tinned copper tape shall be installed between such pieces of apparatus.

3.18.7 The main earth electrode resistance shall be less than one ohm. If this value cannot be obtained by driving copper clad steel rods, the Contractor shall provide bore holes until the damp soil is reached for installation of rods. Provide additional Earthing electrodes to meet code requirements.

3.19 HOISTING AND MOVING

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- 3.19.1 Carefully study the architectural and structural drawings with particular reference to the portions of the structure which are reinforced to withstand the forces applied during the transporting of heavy equipment across that structure.
- 3.19.2 Devise methods and schedules for the hoisting and transportation of equipment from grade to roof and then into the building, to ensure that no damage occurs to the structure, finish, or any other part of the building. Ensure that the schedule meets with the approval of the Construction Manager.
- 3.20 **INSERTS, SLEEVES, AND ESCUTCHEONS**
- 3.20.1 Supply, locate and set all inserts, anchor bolts and sleeves in time when walls, floors and roof are erected.
- 3.20.2 Use only factory made threaded or toggle type inserts, properly sized for the load to be carried.
- 3.20.3 Provide a dimensioned sleeving layout to the Construction Superintendent indicating sizes of sleeves and other structural openings.
- 3.20.4 Do all drilling for hangers, rods and inserts, etc., not placed at time of building erection. Do not use powder actuated tools, except on written permission by the Consultant.
- 3.20.5 Pipe sleeves shall be standard weight steel pipes, machine cut flush with finished structure.
- 3.20.6 Sleeves in waterproof floors shall extend in 102mm (4") above the floor (mechanical rooms, kitchens, etc.).
- 3.20.7 Cover exposed sleeves in finished areas with satin finished chrome or stainless steel escutcheon plates with set screws.
- 3.20.8 Provide sleeves in below grade wall with waterproofing flange.
- 3.20.9 In mechanical rooms and on top of shafts the concrete division shall provide 102mm (4") high (minimum) concrete curbs.
- 3.20.10 Seal all unused sleeves and openings around conduits and ducts with resilient non combustible material. In waterproof sleeves provide additional silicon base seal.
- 3.20.11 Provide and install steel bumper guards around all piping, ductwork, etc., susceptible to being damaged.

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3.20.12 All conduits, etc., which pierce quarry tile and/or ceramic tile must be sealed and made watertight.

3.21 INSTALLATIONS

3.21.1 All electrical wiring and cables shall be installed in conduit or approved electrical raceways in compliance with the OESC.

3.21.2 All work shall be executed in a professional manner and shall conform to the highest standards applicable.

3.21.3 Install equipment in accordance with the general arrangement drawings. Unless actual dimensions are indicated, take such dimensions from final reviewed shop drawings and at the site.

3.21.4 Coordinate with the type of concrete floors/slab construction including the finish concrete surface. Ensure co-ordination with relevant divisions for the installation of all electrical equipment to be installed under this Division is installed prior to the casting of concrete slabs.

3.21.5 Line up exposed conduit parallel or at right angles to building lines. Set, plumb and level equipment accurately, install hanger rods plumb and without offsets, install rows of fixtures accurately in line and level.

3.21.6 Flush-mount boxes, panels, cabinets and electrical devices in finished areas and provide suitable flush trims and doors or covers, unless specifically noted otherwise.

3.21.7 All areas shall be considered finished areas except the pump rooms, mechanical rooms, chiller yard, energy transfer station and areas exposed to weather.

3.21.8 The locations of switches, outlets and control devices are shown diagrammatically only. Mount switches and other controls as close to doorjamb and other openings as possible, maintaining a minimum of 100mm from trims of doors except where installed in doorframes of metal partitions. Ensure that these locations meet with the approval of the Engineer. Check all door swings and install switches on strike side of door. Mount to code requirements.

3.21.9 Where the location of any item is shown on the architectural details or elevations, this location shall govern. No change to the contract sum shall be allowed for the relocation of any equipment improperly installed because of the failure to check all such details

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prior to the installation of the equipment. Notify the Engineer where details differ.

3.22 MATERIALS, WORK AND SUPERVISION

- 3.22.1 It is a requirement of the specification that the finished appearance of the project in public areas is of a high architectural standard but not limited to all panels, covers, trim panels, finishes and the like shall be included to provide this required appearance to the satisfaction of the Engineer.
- 3.22.2 The whole of the equipment supplied shall be of proven design and of high class durable finish and suitable for installation in a modern building which will be subjected to excessively heavy usage.
- 3.22.3 The Contractor shall be responsible for ensuring that the components of each system are mutually compatible and integrated to form fully efficient systems complying with the Drawings and specifications.
- 3.22.4 All articles and materials specified to conform to CSA Standards shall be clearly and indelibly marked and stamped with the CSA Standard number specified and other details required by the regulations, except where marking is impracticable when the relevant advice/delivery notes shall include the CSA Standard number with which they are to comply.
- 3.22.5 All materials and work shall be to the satisfaction of the Engineer, particular attention shall be paid to a neat orderly well-arranged installation, carried out in a methodical competent manner.
- 3.22.6 The Contractor shall produce dimensional layout showing the exact location and elevation for the various outlets and shall be responsible to submit drawings/ proposed material in a format to the Engineer's instruction.
- 3.22.7 The Contractor shall maintain a competent supervising Engineer for the work on site throughout the whole of the time for the completion of the Contract. The Engineer shall give prior approval to the appointment of this supervising Engineer and shall have the authority to withdraw this approval at any time.
- 3.22.8 No person shall be allowed to execute any type of work, which is normally carried out by a skilled tradesperson unless he is thoroughly experienced and proficient in the trade concerned. The Engineer shall have the option to require a tradesperson to

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demonstrate their proficiency to the satisfaction of the Engineer.

3.23 TESTING AND COMMISSIONING ON SITE

3.23.1 Upon completion of the installation or part of the installation, the Contractor shall carry out and be responsible for the testing and commissioning all equipment and integral systems, in stages if required, to ensure that it is in proper working order and capable of performing all of its functions in accordance with the specification and to the satisfaction of the Engineer. Site Acceptance Testing inclusive of Individual System Testing, and Factory Acceptance Testing to the satisfaction of the commissioning authority and jurisdiction authority, shall be provided.

3.23.2 The Contractor shall be fully responsible for all equipment until each item of equipment or system or part thereof has been tested, commissioned and accepted by the Engineer.

3.23.3 Any equipment damaged in commissioning shall be replaced with new equipment by the Contractor at their own expense and the equipment or system concerned shall be re-tested and commissioned. No instruction or action of the Engineer shall relieve the Contractor of this responsibility.

3.23.4 The Contractor shall give to the Engineer in writing at least ten days' notice of the date after which he will be ready to make the specified tests on completion of installation. Unless otherwise agreed the tests shall take place within seven days after the said date on such day or days as the Engineer shall in writing notify the Contractor. The tests shall as far as possible be carried out under normal working conditions to the satisfaction of the Engineer and shall extend over such periods as he may direct.

3.23.5 The Contractor shall provide all skilled labor, supervision, apparatus and instruments required for commissioning and testing and within a reasonable time thereafter furnish to the Engineer six certificates of all tests performed and accepted, signed by the Engineer, the Contractor and an authorized person acting on behalf of Local Authority Distribution Company, as prescribed in the appropriate Regulations and Specifications.

3.23.6 If any part of the equipment fails to pass the specified tests, further tests shall, if required by the Engineer, be repeated. The Contractor shall, without delay, put in hand such modifications as are necessary to meet the requirements as described in the Contract and any expense which the Employer may have incurred

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by reason of such further tests may be deducted from the Contract Price.

- 3.23.7 The Contractor shall include for submission of working drawings for the electrical installation to the Local Authority Distribution Company for approval and shall allow for the procurement of the Local Authority Distribution Company test certificate upon completion of the building following inspection of the electrical installation by Local Authority Distribution Company. Acceptance shall not in any way absolve the Contractor of their responsibility for the performance of the equipment after erection as a complete working system in all respects.

3.24 LOAD BALANCE

- 3.24.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

- 3.24.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

- 3.24.3 Submit, at completion of work, report listing phase and neutral currents on panelboards, dry-core transformers and motor control centers, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

3.25 LOCATION OF OUTLETS

- 3.25.1 Locate outlets in accordance with Division 01.

- 3.25.2 Do not install outlets back-to-back in wall; allow minimum 6" horizontal clearance between boxes.

- 3.25.3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3600mm (12'), and information is given before installation.

- 3.25.4 Locate light switches on latch side of doors. Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.26 MANUFACTURERS AND CSA LABELS

- 3.26.1 Visible and legible after equipment is installed.

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3.27 MECHANICAL EQUIPMENT AND WORK

3.27.1 Read together with Divisions 21, 22, 23, & 25 Mechanical and adhere to its requirements. Supply and install all electrical apparatus which is required and is not covered by Divisions 21, 22, 23, & 25 Mechanical.

3.27.2 Motors:

3.27.2.1 Supply and installation of all motors for electrical equipment will be by the Mechanical Contractor.

3.27.3 Except where noted otherwise, all motors will have the following characteristics:

3.27.3.1 1/2 HP and smaller, 120V, 1 PH, 60 Hz

3.27.3.2 1 HP and larger, 600V, 3 PH, 60 Hz

3.27.3.3 The Mechanical Contractor will submit an accurate schedule of all motors. Include for each motor, the HP, rpm, nameplate current, voltage, phase, equipment served, location, electrical characteristics and identification number. Schedule to be reviewed by Division 26 and the Consultant.

3.27.4 Contactors and Control Devices:

3.27.4.1 Supply and installation of all automatic devices controlling mechanical equipment supplied under the Mechanical Division will be by the Mechanical Contractor.

3.27.4.2 Mechanical Contractor shall provide all starters, contactors, MCC's etc., for all equipment supplied by Division 25 such as chillers, boilers, rooftop air conditioning, fans, pumps and heating units, electric reheat coils, etc., as specified in the respective section (See Motor Control Schedule). Division 26 Electrical shall provide disconnect switches for this equipment as required by code. Weatherproof switches shall be provided for all outdoor units.

3.28 MOTOR AND EQUIPMENT WIRING

3.28.1 Provide power wiring connection and, fittings external to all motors, machines, starters, control panels, etc., supplied under this and all other contracts except as noted herein. All line and load side wiring shall be by the Electrical Contractor.

3.28.2 Power wiring will include but not be limited to all raceways,

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conduits, lugs, fittings, disconnect switches, auxiliary devices for 3 phase 600 V, and 3 phase 208 V motors and 1 phase 240 V, 1 phase 208 V, and 1 phase 120 V motors. All wiring to be in accordance with the manufacturer's instructions.

- 3.28.3 All starters, motor control centres, etc., along with line and load side power wiring will be by the mechanical division. This also applied to the packaged units.
- 3.28.4 Packaged units will have integral starters and only power feeders need be provided. The packaged unit starters will be by Mechanical Contractor. The main disconnect switch will be provided by this contractor.
- 3.28.5 The equipment of the mechanical contract shall generally have all control wiring provided by that contract in accordance with the methods and materials specified under Division 216. Exceptions to this include equipment provided by this contract which must interface into the mechanical contract control circuit. This contract shall wire devices into the mechanical contract control circuit and co operate with Mechanical Contractor regarding testing, locations, etc. Examples of this interface include fire alarm systems interconnection, low voltage switching system interconnection, security system interconnection, etc.
- 3.28.6 Where control devices are line voltage, receive these devices from the Contractor providing that system, install all power wiring to the devices and install the devices.
- 3.28.7 The use of "lock off stop" devices will not be permitted. Provide disconnect switches for all motors that are 30' (9 m) or greater away from the motor starter or if the distance is less, provide disconnect switches for the motors where the motor starter is not visible.
- 3.28.8 All two (2) speed and delta wye motors shall have an adequate number of properly sized feeders between the starters and motors to allow for operation. Note that all remote disconnect switches located adjacent to 2 speed motors and delta wye shall be 6 pole with an auxiliary contact.
- 3.28.9 Control wiring shall be provided by this contract for the work of all contracts other than Division 15 contracts as noted on the drawings and called for herein. Control wiring includes the wiring of all control devices that are connected into control circuits of motor starters and into motor power feeders. Wiring shall be in

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accordance with manufacturers wiring diagrams and instructions. This includes production equipment, computer equipment, overhead doors, dock levelers, elevating docks, security systems, ASRS door controls, C.I.M. systems, etc.

- 3.28.10 Load side wiring for remote VFD and soft-start drives shall be provided by the Mechanical Contractor. Load side wiring for VFD's shall be drive RX type cable appropriately sized. Any disconnects provided on the load side of VFDs shall have auxiliary contacts interlocked with shunt trip of VFD.
- 3.28.11 Power for building automation or like control system panels shall be provided by this contractor. The drawing package will indicate a branch circuit and junction box in each mechanical area. This contractor shall provide wiring to the respective control panel locations as located by the controls contractor. Final connections are not indicated on the electrical drawings, however remain part of this contract.
- 3.29 **MOUNTING HEIGHTS**
- 3.29.1 Mounting height of equipment is from finished floor to centerline of equipment unless specified or indicated otherwise.
- 3.29.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- 3.29.3 Refer to architectural drawings for mounting height of devices and equipment. Should there be a discrepancy between the mounting height noted in electrical and architectural construction documents, obtain clarification from the consultants prior to proceeding with the rough-ins.
- 3.29.4 Mounting height of the control devices (ie. switches, thermostats, intercom, etc.) located in designated barrier-free spaces or the barrier-free path of travel shall conform to the requirement of OBC article 3.8.1.5 (1).
- 3.29.5 Install electrical equipment at following heights unless indicated otherwise:
 - 3.29.5.1 Local switches: 1,100 mm.
 - 3.29.6 Wall receptacles:
 - 3.29.6.1 General: 300mm.

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- 3.29.6.2 Above top of continuous baseboard heater: 150mm.
- 3.29.6.3 Above top of counters or counter splash backs: 150mm.
- 3.29.6.4 In mechanical rooms: 1200mm.
- 3.29.6.5 Panelboards: as required by Code or as indicated.
- 3.29.6.6 Telephone and interphone outlets: 300mm.
- 3.29.6.7 Wall mounted telephone and interphone outlets: 1100mm.
- 3.29.6.8 Television outlets: 305mm.
- 3.29.6.9 Wall mounted speakers: 2100mm.
- 3.29.6.10 Doorbell pushbuttons: 1100mm.

3.30 **OCCUPANCY REQUIREMENTS FOR FINA: FULL AND PARTIAL
OCCUPANCY OF AREAS**

- 3.30.1 The following are the Occupancy requirements for full and partial occupancy of areas.
- 3.30.2 Partial occupancy and occupancy will be provided as requirement for turnover of each phase or partial phase of work that has been completed and areas as required by the Owner in order to maintain function of the building and there operations. Warranties will be as per the signed contract.
- 3.30.3 The requirements below shall be completed two weeks prior to the scheduled turn over date and all required documentation shall be submitted to the Owner and the Consultant for review and comments. At a minimum the above must be submitted two week prior to the scheduled turn-over date.
- 3.30.4 Provide a copy of the ESA Hydro Completion and Final Clearance Certificate.
- 3.30.5 Provide a letter confirming that fire proofing has been installed in area(s) that are to be occupied.
- 3.30.6 Distribution Equipment labelling has been completed.
- 3.30.7 Staff trainings as well as required Practical Training have been completed to the Owners and that of the Consultants' requirements and satisfaction. Provide a list of Names of the Attendees.

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- 3.30.8 Provide a letter confirming that the Labelling of Emergency Power Light Fixtures has been completed.
- 3.30.9 Submission of the Project Field Working and Record Drawings for the area(s) to be occupied has been completed and they have been reviewed and accepted.
- 3.30.10 Recording and provision of Fire Alarm System Hex address for the fire alarm system are shown on the Record Drawings and installed within the panels.
- 3.30.11 Provide a letter Panel schedules are typed confirming that the Emergency lighting has been tested and the light levels that are present meet Building Code Requirements.
- 3.30.12 Infrared Thermo Scan has been completed and test reports submitted for review – for modified or new electrical distribution equipment.

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- 3.30.13 Provision of Record Single Distribution Diagram(s) in main electrical and secondary electrical rooms that reflect the modifications to the Normal and Emergency Power distribution systems.
- 3.30.14 Short Circuit Protection & Coordination and Arc Flash Studies have been completed and submitted and been reviewed by the Electrical Consultant.
- 3.30.15 Provide a letter confirming that the power distribution for both Normal and Emergency - protection equipment has been adjusted to the setting as recommended in the coordination study for the normal and emergency distribution systems.
- 3.30.16 Provide a letter confirming that the Arc Flash Labelling has been installed on the Electrical Distribution Systems.
- 3.30.17 Lighting test reports for Emergency Lighting (including areas covered by Battery Units) have been submitted and meet Building Code Requirements.
- 3.30.18 Removal all temporary wiring.
- 3.31 OPERATION AND MAINTENANCE MANUALS
- 3.31.1 Submit operation and maintenance manuals in accordance with Division 01.
- 3.31.2 Include the following information in the Operation and Maintenance manuals:
 - 3.31.2.1 Names and address of local suppliers for the items included.
 - 3.31.2.2 Details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of the installation.
 - 3.31.2.3 Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items and parts lists. Advertising or sales literature is not acceptable.
 - 3.31.2.4 Review information provided in the maintenance instructions and manuals with the Owners' operating personnel to ensure a

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complete understanding of the electrical equipment and systems and their operation.

3.32 PERMITS, FEES, AND INSPECTION

3.32.1 Submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.

3.32.2 Pay associated fees.

3.32.3 Consultant will provide drawings and specifications required by Electrical Inspection Department and Supply Authority at no cost. Drawings are to be submitted by the Electrical Contractor.

3.32.4 Notify Consultant of changes required by Electrical Inspection Department prior to making changes.

3.32.5 Furnish Certificates of Acceptance from Electrical Inspection Department authorities having jurisdiction on completion of work to Consultant.

3.33 PLYWOOD

3.33.1 Supply and install all plywood backboards required for the work of this Division. Plywood to be highest quality fire retardant fir, 1219mm (4'-0") wide x 2438mm (8'-0") high, 19mm (¾") thick unless otherwise specified. Prime and paint backboards on both sides with fire retardant paint, equal to CGSB Spec. #1-GP-151M, of a colour to match the equipment and services mounted thereon as defined in "Finishes" above.

3.34 PROGRESS PAYMENTS

3.34.1 Submit a complete breakdown of the Contract with each progress billing, indicating percentage of work complete, in a form acceptable to the Owner/Consultant.

3.34.2 The contractor shall provide a work breakdown structure to include an itemized list of work and associated cost structure for consultant review prior to the first billing.

3.34.3 The work breakdown separate supply and installation where material cost exceeds \$30,000.

3.34.4 Progress draw breakdowns shall include both dollar value and percentage value for the following: Contract Value, current billing,

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previous billing, and complete to date categories.

3.34.5 The contractor may claim a maximum of 95% against the supply category until such time as the system is installed and is fully functional.

3.34.6 Where indicated as a separate category, any systems requiring programming or manufacturer start-up shall be subject to a minimum 10% hold in addition to the above, until such time as the system is fully functional.

3.34.7 Where not indicated as a separate category, any systems requiring testing or test results shall be subject to a minimum 10% hold in addition to the above, until such time as the system is fully functional.

3.35 PROTECTION

3.35.1 Protect building and structure from damage due to carrying out this work.

3.35.2 Protect all electrical work from damage. Keep all equipment dry and clean at all times.

3.35.3 Cover all opening in equipment and materials.

3.35.4 Be responsible for and make good any damage caused directly or indirectly to any walls, floors, ceilings, woodwork, brickwork, finishes, etc.

3.36 RECORD OF DRAWINGS

3.36.1 The Consultant will provide the Contractor with one (1) disk containing all drawings relating to the work of this Contract in AutoCAD format. The contractor shall clearly mark, as the job progresses, all changes and deviations from that shown on contract drawings. Drawings shall be kept up-to-date during construction and in addition to field measurements shall include variation orders, field instructions and all other changes. After inspection and approval of service lines in trenches, the contractor shall take as-built measurements, including all depths, prior to backfilling operations. It will not be sufficient to check off line locations. Definite measurements shall be taken for each service line. The location of buried duct banks, etc. shall be shown on the drawings from fixed points. On completion of the building, the contractor shall forward to the Consultant the two sets of drawings

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indicating all such changes and deviations for review. Include in the tender price, the cost for the production of CAD diskette record drawings by the Consultant's staff.

3.37 SHOP DRAWINGS

3.37.1 Refer to article on shop drawings in Division 01.

3.37.2 Shop drawings shall indicate clearly the materials and/or equipment actually being supplied, all details of construction, accurate dimensions, capacity, operating characteristics and performance. Each shop drawing shall give the identifying number of the specific piece of equipment etc. for which it was prepared (e.g. panel #2A).

3.37.3 Each shop drawing for non-catalogue items shall be prepared specifically for this project. Shop drawings and brochures for catalogue items shall be marked clearly to show the items being supplied.

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- 3.37.4 Each shop drawing or catalogue sheet shall be stamped and signed by the contractor to indicate that he has checked the drawing for conformance with all requirements of the drawings and specifications, that he has coordinated this equipment with other equipment to which it is attached and/or connected thereto and that he has verified all dimensions to ensure the proper installation of equipment within the available space and without interference with the work of other trades. Ensure that mechanical coordination is complete before submitting drawings for review.
- 3.37.5 Installation of any equipment shall not start until after final review of shop drawings has been obtained.
- 3.37.6 When requested, shop drawings shall be supplemented by data explaining the theory of operation.
- 3.37.7 The General Requirements Division shall apply except as amended above.
- 3.38 SINGLE LINE ELECTRICAL DIAGRAMS
- 3.38.1 Provide single line electrical diagrams under plexiglass as follows:
- 3.38.1.1 Electrical distribution system: locate in main electrical room.
- 3.38.1.2 Electrical power generation and distribution systems: locate in power plant rooms.
- 3.38.1.3 Provide fire alarm riser diagram, plan and zoning of building under plexiglass at fire alarm control panel and annunciator.
- 3.38.1.4 Drawings: 610mm x 610mm (2' x 2') minimum size.
- 3.39 TEMPORARY SERVICES
- 3.39.1 Temporary electrical service shall be provided by others, unless otherwise noted. Coordinate with General Contractor for further detail.
- 3.39.2 Do not use any of the permanent electrical systems during construction, unless specific written approval is obtained from the Consultant or unless allowed elsewhere in the contract documents.

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3.39.4 The use of permanent facilities for temporary construction service shall not affect in any way the commencement period in which correction after completion is the Contractor's responsibility. Such period will commence only when the overall project is completed and certificates are issued.

3.40 VALUATION OF CHANGES

3.40.1 Refer to and conform to the requirements set out in Division 01 and Electrical Tender Form.

3.40.2 Submissions will be scrutinized by the Consultant and therefore require complete detailed itemization of all material, labour, unit prices and overhead and profit mark-ups.

3.41 WORK ASSOCIATED WITH OTHER TRADES OR PARTIES

3.41.1 Some works and/or provisions associated with the Electrical Services shall be performed by other trades or parties. Liaise and co-ordinate with other trades to ensure that all requirements are provided as required for the completeness and proper operation of the equipment or system.

3.42 TAGS AND DIRECTORY

3.42.1 After finished painting is completed, identify each main feeder cable and conduit service. Locate identification:

3.42.1.1 Behind each access door.

3.42.1.2 At each change of direction and at junction boxes.

3.42.1.3 At not more than 12 meters (40') apart in straight runs of exposed conduit, but on both sides of sleeves.

3.42.1.4 At not more than 12 meters (40') apart in straight runs of conduit behind removable enclosures such as lay in type ceiling, cut on both sides of sleeves.

3.42.1.5 Use stencils and stencil paint or use lamacoid plates on all conduit and ductwork.

3.42.1.6 Use letters of minimum 25mm (1") high.

3.42.1.7 The identification shall describe system voltage and services; e.g. "120/208 Volt lighting fed from panel 2A".

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- 3.42.2 Conduits and outlet boxes for the various systems shall be identified by the use of distinctive colour paints. Identification of raceways shall consist of painted junction box covers and pointed conduit couplings. The following colours shall be used:
- 3.42.2.1 120/208 Volt System – Orange
- 3.42.2.2 600 Volt System – Blue
- 3.42.2.3 Telephone Conduit System – Green
- 3.42.2.4 Intercom and Low Voltage Signal Systems – Black
- 3.42.2.5 Emergency System – Yellow
- 3.42.3 All high voltage raceways shall be labelled "DANGER 13.8 kV" in accordance with OESC, at 3' (3 m) intervals along raceway.
- 3.42.4 Have the manufacturers nameplate affixed to each item of all equipment showing the size, name of equipment, serial number and all information usually provided, including voltage, frequency, # of phases, horsepower, etc., and the name of the manufacturer and their address. Ensure that all stamped, etched and engraved lettering on plates is perfectly legible. Ensure that nameplates are not painted over. Where apparatus is to be concealed, attach the nameplate in an approved location on the equipment support or frame.
- 3.42.5 Identify all equipment with the corresponding remote controls.
- 3.42.6 Ensure that panels and other apparatus which have exposed faces in finished areas do not have any visible trademarks or other identifying symbols. Mount nameplates behind doors.
- 3.42.7 All outlet boxes provided in the ceiling space for future lighting and/or power connections shall be identified on the box cover with brady self-sticking markers indicating circuits contained in the box.
- 3.43 TRIAL USAGE AND INSTRUCTION TO OWNER
- 3.43.1 The Owner has the privilege of the trial usage of electrical systems or parts thereof for the purpose of testing and learning the operational procedures.
- 3.43.2 Carry out the trial usage over a length of time as deemed reasonable by the Consultant at no extra cost.

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- 3.43.3 Carry out the operations only with the express knowledge and under supervision of the construction manager who shall not waive any responsibility because of the trial usage.
- 3.43.4 Trial usage shall not be construed as acceptance by the Owner.
- 3.43.5 Instruct the Owner's representative in all aspects of the operation of systems and equipment.
- 3.43.6 Arrange for and pay for services of service engineers and other manufacturer's representatives required for instruction on specialized portions of the installation.
- 3.43.7 Submit to the Consultant at the time of final inspection, a complete list of systems stating for each system.
- 3.43.8 Date instructions were given to the Owner's staff.
- 3.43.9 Duration of instruction.
- 3.43.10 Name of persons instructed.
- 3.43.11 Other parties present (manufacturer's representative, Consultants, etc.).
- 3.43.12 Signature of the Owner's representatives stating that they properly understood the system installation, operating and maintenance requirements.
- 3.44 VIBRATION ISOLATION
- 3.44.1 Provide vibration isolation control as necessary so as to prevent transmission of objectionable vibration to the building structure, and from one area to another.
- 3.44.2 Provide all steel bases and concrete inertia pads. Install all bases to clear the sub-base (housekeeping pads) by minimum 25mm (1") for steel bases, and 50mm (2") for concrete bases.
- 3.44.3 All floor mounted equipment shall be erected on 102mm (4") high reinforced concrete pads. Concrete pads shall be of similar dimensions to that of the foot print of the equipment. Wherever vibrations eliminating devices and/or concrete inertia blocks are specified, these items shall, in all cases, be mounted upon the 102mm (4") high reinforced concrete pads; unless specified to the contrary.

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3.44.4 All concrete foundations and supports shall be provided by this division. This contractor shall provide dimensioned drawings and details of all such work required and shall submit same to the Consultant for approval.

3.45 FLASHING

3.45.1 Provide galvanized or aluminum sleeves for piping through roof.

3.45.2 Ensure that the flashing suits roof and extends minimum 450mm (18") on all sides. Leave flashing as directed by the Contractor, to be built into roofing, rendering a watertight connection.

3.45.3 Provide counter flashing on diesel and boiler exhaust stacks, ducts, and pipes passing through roofs to fit over flashing or curb. Coordinate with Roofing Contractor.

3.46 WARNING SIGNS

3.46.1 As specified and to meet requirements of Electrical Inspection Department, Local Authority and Consultant.

3.46.2 Decal signs, minimum size 175mm x 250mm (8" x 10").

3.47 VOLTAGE RATINGS

3.47.1 Operating voltages: to CAN3-C235-83.

3.47.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment

3.48 WORK

3.48.1 Install conduits and pipes parallel and perpendicular to the building planes and concealed in chases, behind furring or above ceiling, except in unfinished areas. Install all exposed systems neatly and grouped together, to present a neat appearance.

3.48.2 Install meters and switches to permit easy reading.

3.48.3 Install all equipment and apparatus requiring maintenance, adjustment or replacement with sufficient clearance for servicing.

3.48.4 Install control devices to guarantee proper sensing. Shield

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element from direct radiation and avoid placing them behind any obstruction.

- 3.48.5 Include in the work all requirements of the manufacturer and as shown on the shop drawings.
- 3.48.6 Replace any work unsatisfactory to the Consultant/Owner without extra cost.

END OF SECTION

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 26 05 00 – Common Work Results Electrical, shall apply to and govern this section.

1.2 CO-ORDINATION BETWEEN NEW AND EXISTING INSTALLATIONS

1.2.1 Check and co-ordinate all systems in the new building addition which are extended to or from existing systems to ensure their proper operation.

1.2.2 Provide interfacing components between new and existing systems as necessary for proper performance and operation.

1.2.3 Active services to the existing facility shall be protected and maintained without interruption.

1.2.4 In areas where it becomes inaccessible for servicing, such as a new drywall ceiling, Remove, extend and relocate all existing junction boxes to an area, which is accessible for servicing, such as a "T-Bar" ceiling, or extend junction box/outlet boxes to the underside of new finished ceiling with decorative cover plates as per Engineers site direction at later date.

1.2.5 Where electrical wiring and/or conduit pass through or in the area to serve items which are to remain, the service shall be maintained.

1.2.6 Whenever existing concealed finishes (such as drywall bulkhead, suspended ceiling and drywall ceiling, furred-out wall space, etc.) is to be demolished and replaced with exposed structure, replace all active wiring including Bx cable concealed behind existing finishes and which have become exposed during renovation work with wiring in metal conduit and/or wiremold. All existing outlet boxes, junction boxes and devices mounted in or on the existing concealed finishes and/or any existing wiring in conduit installed in the existing concealed finishes shall be relocated and/or rerouted to the final finished structural of routing, method and detail as later directed by the Engineer on site to suit site condition.

1.2.7 Offset existing conduit, wiring where necessary to suit new mechanical, architectural and structural work.

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- 1.2.8 Relocate existing devices such as switches, receptacles, outlet boxes, pull stations, telephone, cable TV and computer outlets, fire alarm system components, emergency lights, exit signs and including lighting fixtures where required to suit new wall and ceiling finishes.

1.3 PENETRATIONS IN EXISTING STRUCTURE

- 1.3.1 Do all cutting and core drilling for the Work of this Division. Obtain Consultant's approval before proceeding.

- 1.3.2 Provide sleeves and follow Consultant's instructions where necessary to completely penetrate existing floors, walls, ceiling, roof or structural members.

- 1.3.3 Scan all proposed penetrations of concrete slabs to locate hidden services before penetrating existing structure. Advise Consultant of any interference.

- 1.3.3.1 Where the results of the scanning(s) will not permit the cable/feeder/conduits risers location due to structural or other reason(s), re-scan alternate location(s) as directed by Engineer on site until a suitable location is found. Sufficient allowance shall be carried by the Contractor for initial scanning, and all subsequent scanning(s) and subsequent rerouting of new riser(s) to another location to suit site condition at no extra costs to the Contract.

- 1.3.4 Do all necessary patching and repairing. Maintain integrity of fire ratings.

- 1.3.4.1 Whenever the existing conduits/cables are to remain, pack and seal the void between the opening and the existing conduit/cable with fire stop sealant and approved material. Pack and secure in such a manner that the packing in vertical hole and opening will not fall out.

- 1.3.4.2 Whenever the existing conduit/cables are removed, pack and seal the existing opening fire stop sealant and approved material same as above.

- 1.3.5 Flash all parts passing through or built into a roof, outside wall or waterproof floor.

- 1.3.6 If any fire proofing material or insulation on building structure is damaged where mechanical equipment has been removed or added, Contractor to repair at this Division's expense.

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1.4 USE OF EXISTING MATERIAL AND EQUIPMENT

- 1.4.1 Test existing equipment, which is to remain in areas being renovated for proper operation. Repair as necessary. Clean, test for proper operation and repair existing equipment to be relocated before being put back into service. Identify required repairs in written report to Consultant.
- 1.4.2 Repair or replace, without adjustment to the Contract price, all existing equipment, which is damaged in process of relocation.
- 1.4.3 Unless noted otherwise provide additional equipment of the same type and manufacturer where required to supplement existing equipment.
- 1.4.4 Whenever existing electrically operated equipment is removed from its present location or re-installed elsewhere, remove redundant existing conduits, boxes, cables, fixtures, etc. and openings in boxes, raceways, panels, etc. which may result from such removal of equipment shall be closed in a proper manner and all cables and wires properly terminated and insulated to restore the system to a safe and sound condition and to the Engineer's satisfaction.
- 1.4.5 Subject to the Engineer's approval, Contractor may re-use existing wiring and conduit work provided the wiring is tested and meggered. Wiring or conduit work found defective shall be replaced.
- 1.4.6 Review existing equipment on site to determine operating conditions prior to Tender.

1.5 SALVAGE MATERIALS

- 1.5.1 Remove from the site all materials in renovated areas of the existing building which are not to remain or be reused, unless noted as remaining the property of the Owner.
- 1.5.2 All materials and/or equipment designated for salvage shall be turned over to the owner. All other materials and/or equipment designated for removal becomes the property of this contractor and shall be promptly removed from site.
- 1.5.3 Contact the owner prior to any demolition work. In addition to the equipment and/or material as shown on the drawing, the owner will designate which equipment and/or materials are to be salvaged.

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Demolition work is to proceed only after owner's approval is obtained.

1.6 EXISTING SERVICES

- 1.6.1 Disconnect and remove all existing products, which are abandoned.
- 1.6.2 Remove all piping, which is abandoned except inaccessible piping in furred-in space. Cut and cap piping below finished surfaces.
- 1.6.3 Plug and cap all abandoned drain and vent points in systems, which are being reused. Plug and cap to the approval of the local authorities.
- 1.6.4 Allow for all work necessary to complete the alterations, rerouting and/or repositioning of existing services and equipment, and all interconnections of new and existing systems.
- 1.6.5 Verify the location and size of all existing services before proceeding with the work.
- 1.6.6 Keep all sprinkler, standpipe and other fire and life safety protection systems in operation at all times. Where this is not possible, advise Construction Manager.

1.7 INTERRUPTION OF SERVICES

- 1.7.1 All shut downs and interruption to existing electrical services shall be fully coordinated with and performed at times acceptable to the Owner.
- 1.7.2 Schedule and perform all work in a manner that will not interfere with the normal business operation or secure integrity of the building operation. To minimize inconvenience to the Building's staff and client, any work which would otherwise interfere with their normal business hours or any work that create objection noise shall be carried out during after building operation hours in a manner that will not interfere with their building operations, or secure integrity.
- 1.7.3 Maintain all electrical and mechanical services to all parts of the building which are in use. Provide temporary services as necessary.

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- 1.7.4 Request permission to interrupt services in writing not less than two (2) weeks in advance and state time(s) and duration(s) of interruptions.
- 1.7.5 Obtain Owner's written approval before interrupting any service. Do not shut down or interrupt any service without such written approval.
- 1.7.6 Arrange all work in such a manner that the shut-downs or interruptions are kept to an absolute minimum. Note that work at the site shall be performed in three (3) eight (8) hour shifts per day, or as directed by the Consultant at a later date.
- 1.7.7 Note that work associated with shut-downs and interruptions shall be carried out as continuous operations to minimize the shut-down time and to reinstate the electrical systems as soon as possible, and, prior to any shut-down, ensure that all materials and labour required to complete the work for which the shut-down is required are available at the site.
- 1.8 PREMIUM TIME
- 1.8.1 Include cost of premium time in Tender Price for work during nights, weekends or other time outside normal working hours necessary to maintain all electrical and mechanical services in operation.
- 1.9 FIRE ALARM SYSTEM
- 1.9.1 Unless specifically noted otherwise, maintain fire alarm system in operation at all times in accordance with governing authorities' rules and regulations.
- 1.10 DISCONNECTION, REMOVAL AND RE-INSTALLATION WORK
- 1.10.1 Contractor shall visit the site and examine existing conditions affecting the work under this contract. Sufficient allowances shall be included in the Tender Price for all the disconnection, removal and re-installation work as required to suit site condition.
- 1.10.2 Include in the tender price removal and re-installation of all lighting fixtures, wiring devices and equipment made necessary due to the renovations and/or installation of new equipment.

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- 1.10.3 Remove all existing electrical equipment, wiring, conduits and devices where not to be reused and as shown on the drawing. Where equipment is removed, cut-off at the point of supply, remove wiring and make the system safe.

END OF SECTION

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Section Name: **Backboards**
Section No.: **26 05 15**
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1 **GENERAL**

1.1 GENERAL

- 1.1.1 Provide plywood backboards for mounting of all electrical, telecommunications, and security equipment unless noted otherwise on the drawings.

2 **PRODUCTS**

2.1 BACKBOARDS

- 2.1.1 Construct plywood backboards from 19mm thick fir plywood, good one (1) side.
- 2.1.2 Use fire retardant backboards, pressure impregnated with fire retardant chemicals, and stamp.
- 2.1.3 Conform to CSA 080.

3 **EXECUTION**

3.1 INSTALLATION

- 3.1.1 Construct each backboard in a rectangular shape of the size as indicated. Where no size is indicated, provide a backboard minimum 100mm wider and 100mm higher than the equipment. Where more than one (1) piece of equipment is installed on the backboard, construct the backboard of a size to suit the maximum vertical and horizontal dimensions of the equipment.
- 3.1.2 Fastenings:
- 3.1.3 Fasten each backboard to a wall or to a support structure using cadmium plated hardware. Provide a flat washer under the head of each fastener. Recess the head of the mounting bolt where equipment, including future equipment, is to be installed.
- 3.1.4 Use expansion shields, toggle bolts or other types of wall fastenings to suit the wall type, Align the mounting bolts with the wall studs for stud type walls.
- 3.1.5 Install fastenings a maximum 500mm apart in both the vertical and horizontal directions.
- 3.1.6 When installing equipment heavier than 50kg, fasten the

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equipment through the backboard directly to the wall or support structure.

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Project No.: 2024-0112
Section Name: **Low-Voltage Electrical Power Conductors and Cables**
Section No.: **26 05 19**
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1 **GENERAL**

1.1 REFERENCE

1.1.1 Comply with the requirements of Section 26 05 00 Common Work Results – Electrical.

1.1.2 Section 26 05 24 – Wiring Methods.

1.1.3 Conform to relevant sections of specifications for this and other Divisions.

1.2 PRODUCT DATA

1.2.1 Submit product data in accordance with Section 26 05 00 Common Work Results – Electrical.

1.3 STANDARDS

1.3.1 TECK 90 cables to CSA Standard C22.2 No.131-M89.

1.3.2 Thermostat Insulated Wires and Cables to CSA Standard C22.2 No. 38-M1986.

1.3.3 Armoured Cable to CAN/CSA-C22.2 No. 51-M89.

1.3.4 Thermoplastic Insulated Wires and Cables to CSA Standard C22.2 No. 75- M1983 (R1992).

1.3.5 All cables installed in areas requiring fire rating shall conform to test FT-4.

1.3.6 All cables installed in spaces designated as a return air plenum shall conform to test FT-6 or be installed in continuous conduit system.

2 **PRODUCTS**

2.1 BUILDING WIRES

2.1.1 Conductors

2.1.1.1 Copper conductors, of the size as indicated, having a minimum conductivity of 98 percent.

2.1.1.2 Stranded copper conductors shall be provided for all wires sizes with ampacity greater than #8 AWG.

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- 2.1.1.3 The minimum wiring size that shall be permitted for this project is No. 12 AWG.
- 2.1.1.4 Conductors shall be minimum No. 12 AWG, size conductor for maximum 2% voltage drop to the furthest outlet on a fully loaded branch circuit.
- 2.1.1.5 The following shall be used with respect to branch circuit wire sizing for voltage drop from the circuit's associated panel board:
 - 2.1.1.5.1 Conductors shall be minimum No. 12 AWG for maximum 2% voltage drop to the furthest outlet/load on a fully loaded branch circuit, where circuit is 20m in length.
 - 2.1.1.5.2 Conductors shall be minimum No. 10 AWG for maximum 2% voltage drop to the furthest outlet/load on a fully loaded branch circuit, where the circuit is less than 30m in length but more than or equal to 20m in length.
 - 2.1.1.5.3 Conductors shall be minimum No. 8 AWG for maximum 2% voltage drop to the furthest outlet/load on a fully loaded branch circuit, where the circuit is less than 45m in length but more than or equal to 30m in length.
 - 2.1.1.5.4 Conductors shall be minimum No. 6 AWG for maximum 2% voltage drop to the furthest outlet/load on a fully loaded branch circuit, where the circuit is less than 60m in length but more than or equal to 45m in length.
- 2.1.1.6 The Electrical Contractor shall up-size feeder and branch circuit wiring and associated conduit as required to meet the requirements of the code with respect to acceptable voltage drop.
- 2.1.2 Insulation
 - 2.1.2.1 RW90 is specified for use throughout. RW90 cable shall have thermosetting polyethylene insulation rated at a minimum of 300V for 120/208V wiring and 600V for 347/600V wiring.
- 2.1.3 Colour Coding:
 - 2.1.3.1 120/208V circuits:
 - 2.1.3.1.1 Two conductor, 1 phase: 1 black, 1 white
 - 2.1.3.1.2 Three conductor, 1 phase: 1 red, 1 black, 1 white

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- 2.1.3.1.3 Three conductor, 3 phase: 1 red, 1 black 1 blue
- 2.1.3.1.4 Four conductor, 3 phase: 1 red, 1 black, 1 blue, 1 white
- 2.1.3.1.5 Ground wires: Green
- 2.1.3.2 347/600V, circuits:
 - 2.1.3.2.1 Two conductor, 1 phase: 1 orange, 1 white
 - 2.1.3.2.2 Three conductor, 1 phase: 1 orange, 1 brown, 1 white
 - 2.1.3.2.3 Three conductor, 3 phase: 1 orange, 1 brown, 1 yellow
 - 2.1.3.2.4 Four conductor, 3 phase: 1 orange, 1 brown, 1 yellow, 1 white
 - 2.1.3.2.5 Ground wires: Green
- 2.1.4 Manufacturers:
 - 2.1.4.1 Acceptable manufacturers are:
 - 2.1.4.1.1 Canada Wire and Cable Limited
 - 2.1.4.1.2 General Cable
 - 2.1.4.1.3 SouthWire
 - 2.1.4.1.4 Nexans
- 2.2 TYPE TECK 90 CABLE
 - 2.2.1 Conductors
 - 2.2.1.1 Copper conductors shall be of the sizes indicated, having a minimum conductivity of 98 percent.
 - 2.2.1.2 Each cable shall have a grounding conductor.
 - 2.2.2 Insulation
 - 2.2.2.1 Chemically cross-linked thermosetting polyethylene insulation rated at a minimum of 1000V, type RW 90.
 - 2.2.3 Inner jacket
 - 2.2.3.1 Polyvinyl chloride inner jacket.

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2.2.4 Armour

2.2.4.1 Interlocking aluminum armour.

2.2.5 Overall jacket

2.2.5.1 Thermoplastic polyvinyl chloride LFS/LGE overall jacket for fire protection and low acid gas evolution, meeting the requirements of the Vertical Tray Fire Test to CSA Standard C22.2 No. 0.3-92 with a maximum flow travel of 1200 mm. (Conform to FT4).

2.2.6 Fastenings

2.2.6.1 One hole malleable iron straps to secure surface mounted cables.

2.2.6.2 12-gauge galvanized steel channel type supports for two or more cables at 1500 mm centres.

2.2.6.3 1/4" diameter threaded rods to support the suspended channels.

2.2.7 Connectors

2.2.7.1 Watertight TECK connectors, T & B series 10464 and 10470.

2.2.8 Manufacturers

2.2.8.1 Acceptable manufacturers are:

2.2.8.1.1 Nexans;

2.2.8.1.2 General Cable;

2.2.8.2 Southwire;

2.2.8.3 United Wire and Cable.

2.3 ARMOURED CABLES

2.3.1 AC90 Cable:

2.3.1.1 Conductors: Copper conductors, of the sizes as indicated, having a minimum conductivity of 98%.

2.3.1.2 Insulation: Chemically cross-linked thermosetting polyethylene insulation rated at a minimum of 600 V.

2.3.1.3 Armour: Interlocking armour fabricated from aluminum strip.

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2.3.1.4 Shall be provided with an integral insulated ground wire.

2.3.1.5 Colour Coding:

2.3.1.5.1 2 conductor, 1 phase: 1 black, 1 white

2.3.1.5.2 3 conductor, 1 phase: 1 black, 1 red, 1 white

2.3.1.5.3 Ground wire: green

2.4 MINERAL-INSULATED CABLES

2.4.1 Conductors: Solid bare soft-annealed copper conductors, of the sizes as indicated.

2.4.2 Insulation Compressed powdered magnesium oxide insulation to form a compact homogeneous mass throughout the entire length of the cable.

2.4.3 Sheath:

2.4.3.1 An annealed seamless copper sheath, Type MI, rated 600 V, 250 C.

2.4.3.2 Termination Kits: Provide copper termination kits at each end of each cable.

2.4.4 Manufacturers: Acceptable manufacturers for MI cable are:

2.4.4.1 Pyrotenax of Canada Limited.

2.5 CONTROL CABLES

2.5.1 300V control cable: Stranded annealed copper conductors sized as indicated, with TWH thermoplastic insulation with a shielding of 100% coverage of aluminum polyester tape and drain wire over each group and overall conductors, and an overall jacket of PVC.

2.5.2 300V cables shall conform to CSA standards CAN 3-C21.2 M86.

2.5.3 Custom control cables shall be designed and assembled in the configurations as indicated.

2.5.4 Each conductor shall be black and number coded, pairs shall be black and white and number coded.

2.5.5 Manufacturers: Acceptable manufacturers are:

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2.5.5.1 Nexans

2.5.5.2 General Cable

2.5.5.3 Southwire

2.5.5.4 United Wire and Cable

2.5.5.5 Delco

2.5.5.6 Belden

2.6 DRIVE RX CABLES FOR VARIABLE FREQUENCY DRIVES (VFD) APPLICATIONS

2.6.1 All Variable Frequency Drives both unit and remote mounted shall use Drive RX cables between the VFD unit and the motor served by the VFD.

2.6.2 Drive RX cables shall be copper conductor with 1000 volt insulation rating and include three grounds and have an aluminum sheath continuously corrugated and have a PVC jacket.

2.6.3 Drive Rx cabling shall comply with C.S.A. Standard C22.2 No. 123-96 (R001).

2.6.4 Manufacturers: Acceptable manufacturers are:

2.6.4.1 Nexans

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Install grounding, grounded and neutral conductors without any fuses, switches or breakers of any kind unless otherwise indicated.

3.1.2 Ground the grounded or neutral conductor at the source of supply as indicated and isolate the grounded or neutral conductor at all other locations.

3.1.3 Do not use any grounded or neutral conductors as a grounding conductor.

3.1.4 Do not use any grounding conductor as a grounded or neutral conductor.

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- 3.1.5 Do not splice any wiring in any raceway. Make splices only at junction boxes.
- 3.1.6 Provide sufficient slack at the connection points of conductors to permit proper connections to be made.
- 3.1.7 Do not install any conductors in any raceway until the raceway is complete and cleared of all obstructions.
- 3.1.8 Install all conductors in any one conduit at the same time taking care not to twist the conductors.
- 3.1.9 Use wire pulling lubricants that will not shorten the life of the insulation.
- 3.1.10 Do not install any wires or cables at temperatures above or below those which will cause damage to the wires or cables.
- 3.2 INSTALLATION OF BUILDING WIRES
- 3.2.1 Install wiring as follows:
 - 3.2.1.1 In conduit systems in accordance with Section 26 05 34.
- 3.3 INSTALLATION OF TECK 90 1000 V
- 3.3.1 Install cables as indicated.
- 3.3.2 Group cables wherever possible on channels.
- 3.3.3 Terminate cables in accordance with Section 26 05 20.
- 3.4 INSTALLATION OF ARMOURED CABLE
- 3.4.1 Group cables wherever possible.
- 3.4.2 Terminate cables in accordance with Section 26 05 20.
- 3.4.3 Shall only be permitted for the final connection to light fixtures and the length of the drop shall not exceed 3 meters. BX shall not be permitted for any other use on this project.
- 3.5 INSTALLATION OF MINERAL INSULATED CABLE
- 3.5.1 Install cable exposed, as indicated securely supported by stainless steel straps. Strap cable every 4 feet along the length of the cable with stainless steel straps.

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- 3.5.2 Make cable terminations by using factory-made kits.
- 3.5.3 At cable terminations use thermoplastic sleeving over bare conductors.
- 3.5.4 Where cables are embedded in cast concrete or masonry, provide a sleeve for the entry or exit of cables.
- 3.5.5 Do not splice the cables.

END OF SECTION

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Project No.: 2024-0112
Section Name: **Wiring and Box Connectors**
Section No.: **26 05 20**
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1 **GENERAL**

1.1 REFERENCES AND RELATED SECTIONS

- 1.1.1 Comply with the requirements of Section 26 05 00 Common Work Results – Electrical.
- 1.1.2 Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
- 1.1.3 Section 26 05 24 – Wiring Methods.
- 1.1.4 Section 26 05 33.16 – Boxes for Electrical Systems.
- 1.1.5 CSA C22.2No.65-1956 (R1965) Wire Connectors.
- 1.1.6 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

2 **PRODUCTS**

2.1 MATERIALS - GENERAL

- 2.1.1 Provide pressure type wire connectors with current carrying parts of copper sized to fit copper conductors as required.
- 2.1.2 Provide fixture type splicing connectors with current carrying parts of copper sized to fit copper conductors #10 AWG or less.
- 2.1.3 Provide bushing stud connectors in accordance with EEMAC 1Y-2-1961 to consist of:
 - 2.1.3.1 A connector body and a stud clamp for stranded copper conductors.
 - 2.1.3.2 A clamp for stranded copper conductors
 - 2.1.3.3 Stud clamp bolts as required.
 - 2.1.3.4 Bolts for the copper conductors.
 - 2.1.3.5 Sized for the conductors as indicated.
- 2.1.4 Pressure type wire connectors are to be manufactured to CSA C2.22 No. 65. Clamps and connectors are to be manufactured to CSA C22.2 No. 18.

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- 2.1.5 Building wire connectors shall be:
 - 2.1.5.1 For wire sizes up to #6 AWG – Ideal “Wing Nut”.
 - 2.1.5.2 For wire sizes #4 and larger:
 - 2.1.5.2.1 End to end splices – Burndy US
 - 2.1.5.2.2 Parallel splices – Burndy UC
 - 2.1.6 At studs and bus bars – Burndy QQA (CU/AL)
 - 2.1.7 Two or three conductors in parallel – Burndy Q2A or Q3Q (CU/AL).
 - 2.1.8 Cable connectors shall be:
 - 2.1.8.1 For armoured TECK cables, watertight type, with open compounded head – T & B series “Spin-on 2” with corrosion resistant boot.
 - 2.1.8.2 For armoured cables and steel type with nylon insulated throat – T & B “Tite-Bite”.
 - 2.1.8.3 Clamps or connectors for armoured cable, mineral insulated cable, flexible conduit, non-metallic sheathed cable shall be as required.
- 2.2 STANDARD FIXED SPRING TYPE CONNECTORS
 - 2.2.1 Body constructed of polypropylene rated to 105°C. Body shall be wing type. Body shall be threaded to guide wiring to springs. Barrel end shall be long enough to cover bare end of conductors. Body shall be colour coded to indicate size.
 - 2.2.2 Inner spring shall be rated for copper conductors up to 600V. Inner spring shall be designed to reduce corrosion. The spring shall expand to compress the connection.
 - 2.2.3 Manufacturer:
 - 2.2.4 Thomas and Betts Marrette Type II Winged;
 - 2.2.5 Ideal Industries.
- 2.3 VABRATION RESISTANT AND HIGH TEMPERATURE SLEEVE & SCREW TYPE CONNECTORS

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- 2.3.1 Insulator body constructed of rugged phynolic material rated to 150°C. Insulator cap to mechanically lock securely in place to safeguard against loosening from vibrations.
- 2.3.2 Insert sleeve and set screw shall be corrosion resistant brass; rated for copper conductors up 600V. Insert sleeve and set screw shall provide a positive pressure type connection resistant to vibrations and heating cycles.
- 2.3.3 Manufacturer:
 - 2.3.3.1 Thomas and Betts Marrette Set Screw Vibration Proof/Visible Connection;
 - 2.3.3.2 Ideal Industries.
- 2.4 WEATHERPROOF FIXED SPRING TYPE CONNECTORS
 - 2.4.1 Body constructed of polypropylene rated to 105°C. Body shall be wing type. Body shall be threaded to guide wiring to springs. Barrel end shall be long enough to cover bare end of conductors. Body shall be colour coded to indicate size.
 - 2.4.2 Inner spring shall be rated for copper conductors up to 600V. Inner spring shall be designed to reduce corrosion. The spring shall expand to compress the connection.
 - 2.4.3 Pre-filled with silicone-based sealant to prevent corrosion. Suitable interior and exterior wet and damp location installations.
 - 2.4.4 Manufacturer:
 - 2.4.4.1 Ideal Industries Weatherproof Wire Connector
- 2.5 MECHANICAL WIRE CONNECTORS
 - 2.5.1 Tin-plated, cast copper body made from corrosion resistant high strength copper alloy. Serrated barrel for high pull out strength. Barrel to have inspection window to ensure good connection.
 - 2.5.2 Part number and conductor range to be stamped on the connector.
 - 2.5.3 Plated steel hex socket set screw to provide durable electrical contact.
 - 2.5.4 Two hole lugs only where a tong is required.

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2.5.5 Rated for copper conductors up to 600V and 90°C.

2.5.6 Manufacturer:

2.5.6.1 Panduit – Pan-Lug Cast Copper Connectors;

2.5.6.2 Blackburn.

2.6 COMPRESSION WIRE CONNECTORS

2.6.1 Long barrel made from seamless, high conductivity copper tubing, electro tin-plated and burnished to inhibit corrosion. Barrel to have inspection window to ensure good connection.

2.6.2 Colour coded with and stamped to indicate proper crimping die size.

2.6.3 Two hole lugs only where a tong is required.

2.6.4 Rated for copper conductors up to 35KV and 90°C.

2.6.5 Manufacturer:

2.6.5.1 Panduit – Pan-Lug Compression Connectors;

2.6.5.2 Blackburn.

2.7 MECHANICAL LUGS

2.7.1 Solid, high strength, extruded aluminum alloy body, electro tin-plated for corrosion resistance. Inspection window for visible assurance.

2.7.2 Plated steel hex set screw for durable electrical connection.

2.7.3 Part number and conductor range to be stamped on the connector.

2.7.4 Two hole mounting only where a tong is required and mounting pace permits.

2.7.5 Dual rated for copper and aluminum conductors up to 600V and 90°C.

2.7.6 Compatible with equipment to be used with.

2.7.7 Manufacturer:

2.7.7.1 Panduit – Pan-Lug Aluminum Mechanical Connectors

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2.7.7.2 Blackburn

2.8 INSULATED BUTT (HYPRESS) SPLICE

2.8.1 Tinned copper barrel with brazed seam. Barrel to have wire stop to ensure proper insertion length.

2.8.2 Vinyl insulation with expanded wire entry. Colour coded and printed with conductor range.

2.8.3 Rated for up to 600V and 105°C.

2.8.4 Manufacturer:

2.8.4.1 Panduit – Pan-Term Butt Splice.

2.8.4.2 Blackburn

3 **EXECUTION**

3.1 USAGE

3.1.1 Standard Fixed Spring Type Connectors:

3.1.1.1 General purpose wire connections in junction boxes or electrical equipment

3.1.1.2 Indoor dry Locations only.

3.1.1.3 Where vibration is not a concern.

3.1.1.4 Wire sized: #14 - #12 AWG

3.1.2 Vibration Resistant And High Temperature Sleeve & Screw Type Connectors:

3.1.2.1 General purpose wire connections, motor connections, small transformers, vibrating equipment, in junction boxes or electrical equipment

3.1.2.2 Indoor dry locations only.

3.1.2.3 For connection of vibrating equipment, motors, small transformers, etc.

3.1.2.4 Wire sized: #14 - #10 AWG

3.1.3 Weatherproof Fixed Spring Type Connectors:

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- 3.1.3.1 General purpose wire connections in junction boxes or electrical equipment.
- 3.1.3.2 Indoor and outdoor damp and wet locations.
- 3.1.3.3 For all outdoor connections, site lighting, building lighting, parking gates, etc.
- 3.1.3.4 Wire sized: #14 - #10 AWG
- 3.1.4 Mechanical Wire Connectors:
 - 3.1.4.1 General purpose wire connections in junction boxes or electrical equipment for large electrical loads.
 - 3.1.4.2 Provide appropriate insulator and / or waterproof jacket as required.
 - 3.1.4.3 Provide copper bus bars, insulators, and mounting hardware as required to arrange connections in electrical junction boxes.
 - 3.1.4.4 Wire sizes: #8 - #1 AWG
- 3.1.5 Compression Wire Connectors:
 - 3.1.5.1 General purpose wire connections in junction boxes or electrical equipment for large electrical loads.
 - 3.1.5.2 Provide appropriate insulator and / or waterproof jacket as required.
 - 3.1.5.3 Provide copper bus bars, insulators, and mounting hardware as required to arrange connections in electrical junction boxes.
 - 3.1.5.4 Wire sizes: #6 AWG - #750 MCM.
- 3.1.6 Mechanical Lugs:
 - 3.1.6.1 Wire connections to distribution equipment.
 - 3.1.6.2 Select product to suit distribution equipment, conductor sizes, and clearances.
 - 3.1.6.3 Apply a coat of zinc joint compound on the aluminum conductors prior to the installation of the connectors.
 - 3.1.6.4 Provide all accessories for mounting in distribution equipment.

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3.1.6.5 Wire sizes: #6 AWG - #750 MCM.

3.2 INSTALLATION

3.2.1 Remove insulation carefully from ends of conductors and:

3.2.1.1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No.65.

3.2.1.2 Install fixture type connectors and tighten. Replace insulating cap.

3.2.1.3 Install bushing stud connectors in accordance with EEMAC 1Y-2.

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Connectors & Terminations**
Section No.: **26 05 22**
Date: August 30, 2024

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results – Electrical.

1.1.2 Conform to relevant sections of specification for this and other Divisions.

1.2 INSPECTION

1.2.1 Obtain inspection certificate of compliance covering high voltage stress coning from the Inspection Authority Engineer and include it with as-built drawings and maintenance manuals.

2 **PRODUCTS**

2.1 CONNECTORS AND TERMINATIONS

2.1.1 Copper compression connectors as required sized for conductors.

2.1.2 Contact aid for aluminum cables where applicable.

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Install stress cones, terminations, and splices in accordance with manufacturer's instructions.

3.1.2 Bond and ground, as required.

END OF SECTION

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Project No.: 2024-0112
Section Name: **Wiring Methods**
Section No.: **26 05 24**
Date: August 30, 2024

1 GENERAL

1.1 REFERENCES AND RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results - Electrical.
- 1.1.2 Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
- 1.1.3 Section 26 05 20 - Wire & Box Connectors (0 – 1000 VOLTS).
- 1.1.4 Section 26 05 32 - Outlet Boxes, Conduit Boxes & Fittings.
- 1.1.5 Section 26 05 33.16 – Boxes for Electrical Systems
- 1.1.6 Section 26 05 34 - Conduits, Conduit Fastenings & Conduit Fittings.
- 1.1.7 Conform to relevant sections of specification for this and other Divisions.

2 PRODUCTS

2.1 NIL

3 EXECUTION

3.1 GENERAL

- 3.1.1 The wiring method, final connection, and mounting shall be proposed by the Contractor and submitted in writing for each installation type. Unless noted otherwise or to suit particular site conditions, the methods noted in this specifications section shall be considered the minimum standard.

- 3.1.2 General: All wiring shall be recessed when located in finished areas. Surface mounted wiring may be used in mechanical rooms, service spaces. Provide protection to conduits which may be subject to mechanical damage.

3.2 120/208V DISTRIBUTION & 120/208V LIGHTING

- 3.2.1 Wire in conduit for all feeders and feeds to mechanical equipment.
- 3.2.2 Wire in conduit for power branch circuits.
- 3.2.3 Wire in conduit shall be provided for all services for this project.

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- 3.2.4 Wire in conduit for lighting circuits. Final drops to luminaires may be made with Type AC90 cable or wire in conduit. No runs of type AC90 cable shall exceed 3 meters in length. AC90 where used shall be provided with an integral insulated ground wire.
- 3.2.5 Final connection to motors and transformer susceptible to vibration shall be made in flexible conduit.
- 3.2.6 Wire in conduit for dimming systems.
- 3.2.7 Provide spare boxes for emergency lighting fixtures that maybe required by Building Inspector.
- 3.2.8 Provide all power wiring to Millwork.
- 3.2.9 Provide separate minimum No. 12 AWG insulated green ground wire in all conduit runs.
- 3.2.10 Provide a separate No. 10 AWG neutral wire for all circuits.
- 3.3 347/600V DISTRIBUTION
- 3.3.1 Wire in conduit for all feeders and feeds to mechanical equipment.
- 3.3.2 Wire in conduit for power branch circuits.
- 3.3.3 Provide separate minimum No. 12 AWG green insulated ground wire in all conduit and runs.
- 3.3.4 Final connection to motors and transformer susceptible to vibration shall be made in flexible conduit.
- 3.4 FEEDERS 600V & 120/208V
- 3.4.1 Wire in conduit for all feeders.
- 3.4.2 Where specifically noted in the electrical documents, use of armoured cables of the type noted will be acceptable.
- 3.4.3 Each feeder shall be complete with a ground wire, sized as per Code.
- 3.5 TELEPHONE & DATA COMMUNICATIONS SYSTEMS
- 3.5.1 Provide blank coverplates on existing outlets as noted on drawings and provide conduit and boxes for all new outlets.

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3.5.2 Provide pull cord in conduit system.

3.6 SECURITY SYSTEM

3.6.1 Provide blank coverplates on existing outlets as noted on drawings and provide conduit and boxes for all new outlets.

3.6.2 Provide pull cord in conduit system.

3.7 EMERGENCY POWER FEEDER & FEEDS

3.7.1 All emergency feeders and branch circuits and fire alarm system wiring shall have the required fire rating as per the O.B.C.

3.7.2 Emergency circuits and fire alarm system wiring run in ceiling spaces or wall will have to achieve the required fire rating as per the O.B.C. by means of drywall enclosures or use of MICC cables.

3.7.3 Wire in conduit with approved fire rating per authorities having jurisdiction or MICC cables.

3.8 BX CABLING (AC90)

3.8.1 BX shall only be used for final drops to light fixtures only and the drop shall not exceed 3 meters.

3.8.2 BX is not to be permitted for any other use on this project.

3.9 Vibrating Equipment:

3.9.1 Vibrating equipment includes: motors, transformers, pumps, solenoid valves, telecommunications racks or cabinets, UPS, generator, or any equipment that is prone to vibration.

3.9.2 Provide flexible connection by means of minimum 300mm of armoured flexible conduit or liquid tight conduit.

END OF SECTION

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Project No.: 2024-0112
Section Name: **Grounding - Secondary**
Section No.: **26 05 28**
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1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results – Electrical.
- 1.1.2 Section 26 22 13 – Dry Type Transformers Up To 600 V Primary.
- 1.1.3 Conform to relevant sections of specification for this and other Divisions.

1.2 REFERENCES

- 1.2.1 ANSI/IEEE 837-1988, Qualifying Permanent Connections Used in Substation Grounding.
- 1.2.2 CSA Z32.1-M1986, Safety in Anaesthetizing Locations.

1.3 DESCRIPTION OF WORK

- 1.3.1 Work includes providing all materials, equipment, accessories, services, and tests necessary to complete and make ready for operation. All system grounding, equipment grounding, grounding of outlets, special grounding for telecommunication, grounding of raceways and conduits, grounding of electrical distribution equipment, grounding rod and plates, and accessories work shall be in accordance with drawings and specifications and as required for a complete system.

2 **PRODUCTS**

2.1 EQUIPMENT

- 2.1.1 Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.
- 2.1.2 Copper conductor: minimum 3 m (10') long for each concrete encased electrode, bare, stranded, tinned, soft annealed, size 4/0 AWG or as indicated.
- 2.1.3 Rod electrodes: copper clad steel 19 mm ($\frac{3}{4}$ ") dia by 3 m (10') long.
- 2.1.4 Plate electrodes: Copper surface area 0.2 m², 1.6 mm thick.

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- 2.1.5 Grounding conductors: bare stranded copper, tinned, soft annealed, size 4/0 AWG or as indicated.
- 2.1.6 Insulated grounding conductors: green, type RW90.
- 2.1.7 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- 2.1.8 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - 2.1.8.1 Grounding and bonding bushings.
 - 2.1.8.2 Protective type clamps.
 - 2.1.8.3 Bolted type conductor connectors.
 - 2.1.8.4 Thermite welded type conductor connectors.
 - 2.1.8.5 Bonding jumpers, straps.
 - 2.1.8.6 Pressure wire connectors.

3 **EXECUTION**

3.1 INSTALLATION GENERAL

- 3.1.1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- 3.1.2 Install connectors in accordance with manufacturer's instructions.
- 3.1.3 Protect exposed grounding conductors from mechanical injury.
- 3.1.4 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermite process or inspectable wrought copper compression connectors to ANSI/IEEE 837.
- 3.1.5 Use mechanical connectors for grounding connections to equipment provided with lugs.
- 3.1.6 Soldered joints not permitted.

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- 3.1.7 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- 3.1.8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- 3.1.9 Install separate ground conductor to outdoor lighting standards.
- 3.1.10 Install grounding resistance bank, where specified.
- 3.1.11 Connect building structural steel and metal siding to ground.
- 3.1.12 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- 3.1.13 Bond single conductor, metallic armored cables to cabinet at supply end, and provide non-metallic entry plate at load end.
- 3.1.14 Ground secondary service pedestals.

3.2 ELECTRODES

- 3.2.1 Make ground connections to continuously conductive underground water pipe on street side of water meter.
- 3.2.2 Install water meter shunt.
- 3.2.3 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.
- 3.2.4 Install rod electrodes and make grounding connections.
- 3.2.5 Bond separate, multiple electrodes together.
- 3.2.6 Use size 4/0 AWG copper conductors for connections to electrodes.
- 3.2.7 Make special provision for installing electrodes that will give 5 ohm resistance to ground value where rock or sand terrain prevails. Ground as indicated.

3.3 SYSTEM AND CIRCUIT GROUNDING

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3.3.1 Install system and circuit grounding connections to neutral of primary 600 V system, secondary 120V system.

3.4 EQUIPMENT BONDING

3.4.1 Install bonding connections from exposed non-current carrying metal part of equipment including, but not necessarily limited to, the following:

3.4.1.1 Frames of motors;

3.4.1.2 Motor control centres;

3.4.1.3 Starters;

3.4.1.4 Control panels;

3.4.1.5 Panelboards and Distribution Panels;

3.4.1.6 Isolations Switch(es);

3.4.1.7 Communication Rooms and equipment;

3.4.1.8 Transformers;

3.4.1.9 Transfer Switch(es);

3.4.1.10 Raceway systems.

3.5 GROUNDING BUS

3.5.1 Install copper grounding bus mounted on insulated supports on wall of electrical room.

3.5.2 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections size 2/0 AWG.

3.6 COMMUNICATION SYSTEMS

3.6.1 Install grounding connections for telephone, sound, fire alarm, intercommunication systems as follows:

3.6.1.1 Telephones: make telephone grounding system in accordance with telephone company's requirements.

3.6.1.2 Sound, fire alarm, intercommunication systems as indicated.

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3.7 FIELD QUALITY CONTROL

- 3.7.1 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Engineer and local authority having jurisdiction over installation.
- 3.7.2 Perform tests before energizing electrical system.
- 3.7.3 Disconnect ground fault indicator during tests.
- 3.7.4 Weld grounding conductors to underground grounding electrodes.
- 3.7.5 Connect together system neutral, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, earthing conductor in raceways and cables, receptacle ground connectors, and plumbing system.

3.8 INSPECTIONS AND TEST PROCEDURES

- 3.8.1 The tests to be carried out shall include but not be necessarily limited to:
 - 3.8.1.1 Visual and mechanical inspection:
 - 3.8.1.1.1 Inspect physical and mechanical conditions.
 - 3.8.1.1.2 Inspect anchorage.
 - 3.8.1.2 Electrical Tests:
 - 3.8.1.2.1 Perform fall of potential or alternative test in accordance with IEEE Standard 81 on the main earthing electrode or system.
 - 3.8.1.2.2 Perform point-to-point tests to determine the resistance between the main earthing system and all major electrical equipment frames, system neutral, and/or derived neutral points.

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3.8.2 Test Values:

- 3.8.2.1 The resistance between the main earthing electrode and ground should be no greater than two ohms for commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the employer. (Reference ANSI/IEEE Standard 142).

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Hangers and Supports for Electrical Systems**
Section No.: **26 05 29**
Date: August 30, 2024

1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results – Electrical.
- 1.1.2 Section 26 22 13 – Dry Type Transformers up to 600V Primary.
- 1.1.3 Section 26 24 16 – Panelboards Breaker Type.
- 1.1.4 Conform to relevant sections of specification for this and other Divisions.

2 **PRODUCTS**

2.1 SUPPORT CHANNELS

- 2.1.1 U shaped, steel channel, accurately cold rolled formed from 12 gauge, low carbon steel with finished dimensions of 1 5/8" x 1 5/8" (3.1 mm x 3.1 mm), inturned clamping ridges and a continuous slot along one (1) side for the insertion of slotted nuts. Hot dip galvanize the channel after fabrication with a zinc weight of 1.5 oz/ft sq.
- 2.1.2 Nuts with 2 serrated grooves to engage the clamping ridges of the channel, a spring to hold the nut in place during installation and threaded with Unified and American course threads. Case harden and electrogalvanize after fabrication.
- 2.1.3 Electrogalvanized bolts, threaded rod, flat and lockwashers as required.
- 2.1.4 Angle, U, Z and special fittings, brackets, bases, clamps, hangers, couplings and other fittings as required and galvanized unless otherwise indicated.
- 2.1.5 Provide channel and fittings of one (1) manufacturer. Acceptable manufacturers are:
- 2.1.6 Unistrut of Canada Ltd;
- 2.1.7 Burndy Canada Ltd.;
- 2.1.8 Electrovert Ltd.;
- 2.1.9 Pilgrim Technical Products Limited.

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2.2 CONCRETE ANCHORS

2.2.1 Drilled expansion anchors for anchors set in concrete block or poured concrete after the concrete has set. Size the insert and number of anchors so that the maximum load per anchor does not exceed 25% of the manufacturer's published maximum loading.

2.2.2 Provide concrete anchors of one (1) manufacturer. Acceptable manufacturers are:

2.2.2.1 Hilti Canada Ltd.

2.2.3 U channel concrete inserts shall be 12 gauge steel 1 5/8 in. square with insert anchors 1 3/8 in. long and 4 in. on centre. Acceptable manufacturers are:

2.2.3.1 Pilgrim Technical Products Limited;

2.2.3.2 Electrovert Limited;

2.2.3.3 Unistrut.

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.

3.1.2 Secure equipment to poured concrete with expandable inserts.

3.1.3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.

3.1.4 Secure surface mounted equipment with twist clip fasteners to inverted T-bar ceilings. Ensure that T-bars are adequately supported to carry weight of equipment specified before installation.

3.1.5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

3.1.6 Fasten exposed conduit or cables to building construction or support system using straps.

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- 3.1.6.1 One-hole steel straps to secure surface conduits and cables 50 mm (2") and smaller.
- 3.1.6.2 Two-hole steel straps for conduits and cables larger than 50 mm (2").
- 3.1.6.3 Beam clamps to secure conduit to exposed steel work.
- 3.1.7 Suspended support systems.
- 3.1.8 Support individual cable or conduit runs with 6 mm (1/4") diameter threaded rods and spring clips:
 - 3.1.8.1 Support two or more cables or conduits on channels supported by 6 mm (1/4") diameter threaded rod hangers where direct fastening to building construction is impractical.
- 3.1.9 For surface mounting of two or more conduits use channels at 5 m oc spacing.
- 3.1.10 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- 3.1.11 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- 3.1.12 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- 3.1.13 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Engineer.
- 3.1.14 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

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- 3.1.15 Where conduit and equipment is located on walls or slabs which will not permit the support of equipment, provide suitable supports to the building structure. Supports shall be constructed out of steel members or of steel pipe and fittings designed to safely support the equipment.

END OF SECTION

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Project No.: 2024-0112
Section Name: **Outlet Boxes, Conduit Boxes & Fittings**
Section No.: **26 05 32**
Date: August 30, 2024

1 GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results – Electrical.
- 1.1.1 Section 26 05 33.16 – Boxes for Electrical Systems.
- 1.1.2 Section 26 05 34 – Conduits, Conduit Fastenings & Conduit Fittings.
- 1.1.3 Conform to relevant sections of specification for this and other Divisions.

1.2 SHOP DRAWINGS & PRODUCT DATA

- 1.2.1 Submit shop drawings and product data in accordance with Section 26 05 01.
- 1.2.2 Provide samples of all floor boxes for Consultant's review.

1.3 STANDARDS

- 1.3.1 Outlet Boxes, Conduit Boxes and Fittings to C.S.A. C22.2 No.18-92.
- 1.3.2 Rigid PVC Boxes and Fittings to C.S.A. C22.2 No.85-M89.

2 PRODUCTS

2.1 general

- 2.1.1 All device model number listed are intended to represent base specification for design intent. Provide equal product from the acceptable manufacturers.

2.2 OUTLET AND CONDUIT BOXES GENERAL

- 2.2.1 Size boxes in accordance with CSA C22.1 and electrical code
- 2.2.2 All sheet steel boxes shall have pre-punched 19 mm knockouts.
- 2.2.3 Do not use boxes with cable clamps.
- 2.2.4 Boxes shall be minimum size 75 mm x 50 mm x 50 mm deep. Provide 100 mm square or larger outlet boxes as required for special devices. Add extension and plaster rings as required.

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- 2.2.5 Provide 100 mm square or octagonal outlet boxes for luminaire outlets.

[SPECIFICATION NOTE: Select one of the two below as applicable to the project.]

- 2.2.6 Provide multi-gang boxes for power and switching devices, do not gang tel/data system boxes unless detailed specifically.

OR

- 2.2.7 Provide interior baffle divider to separate power and switching devices from low voltage or tel/data wiring.

- 2.2.8 Provide blank cover plates for boxes without wiring devices as described in Section 26 27 26.

- 2.2.9 Provide 347 V outlet boxes for 347 V switching devices.

- 2.2.10 For outlet boxes or devices boxes being installed in rooms designated as pressure controlled space (positive and/or negative pressurized spaces such as lab space), provide putty mat or similar sealing material to complete seal the outside of the outlet boxes. Similarly, ensure associated conduit raceways are sealed to maintain the pressure rating.

- 2.2.11 For outlet boxes or devices boxes being installed in spaces with noise control or sound transmission requirement, such as theatres or recording studio), provide putty mat or similar sealing material to completely seal the outside of the outlet box and limit the sound transmission.

2.3 SHEET STEEL OUTLET BOXES

- 2.3.1 Electro-galvanized steel single and multi-gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm (3" x 2" x 1½") or as required for special devices or as indicated. 102 mm (4") square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

- 2.3.2 Boxes for door switch and pushbuttons shall be sized as required.

- 2.3.3 102 mm (4") square or octagonal outlet boxes for lighting fixture outlets.

- 2.3.4 102 mm (4") square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster or tile walls.

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2.4 MASONRY BOXES

2.4.1 Electro-galvanized steel masonry single and multi-gang MBD boxes for devices flush mounted in exposed block walls.

2.5 CONCRETE BOXES

2.5.1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.6 FLOOR BOXES

2.6.1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brass faceplate. Device mounting plate to accommodate short or long ear duplex receptacles. Minimum depth: 28 mm (1 1/8") for receptacles; 73 mm (3") for communication equipment.

2.6.2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 12 mm and 19 mm (1/2" and 3/4") conduit. Minimum size: 3 mm (3") deep.

2.7 CONDUIT BOXES

2.7.1 Cast FS or FD ferrelloy boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle in all public areas and 1110 utility boxes in all service rooms.

2.8 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE

2.8.1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm (3" x 2" x 2 1/2") with two double clamps to take non-metallic sheathed cables.

2.9 PVC BOXES

2.9.1 All PVC boxes to have approved ground straps and shall be compatible with PVC conduit used.

2.10 FITTINGS – GENERAL

2.10.1 Bushing and connectors with nylon insulated throats.

2.10.2 Knock-out fillers to prevent entry of debris.

2.10.3 Conduit outlet bodies for conduit up to 32 mm (1 1/4") and pull boxes for larger conduits.

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2.10.4 Double locknuts and insulated bushings on sheet metal boxes.

2.11 WEATHERPROOF COVERS

2.11.1 Light switches:

2.11.1.1 Clear bubble plate with silicone rubber for use with all AC toggle switches. Hubbell Cat No. HBL1795

2.11.1.2 For locations with 2-ganged switches and/or 2-gang boxes with single switch and blank, provide custom Hubbell cover to suit requirements.

2.11.2 Fire Alarm Manual Pull Stations:

2.11.2.1 STI Series Stopper II, STI-1250 WeatherStopper Flush Mount kit. Consisting of STI-1230 clear Lexan, UV stabilized pull-station cover, STI-3002 gasket.

2.11.2.2 STI Series Stopper II, STI-3150 WeatherStopper Surface Mount kit. Consisting of STI-1230 clear Lexan, UV stabilized pull-station cover, 2xSTI-3002 gaskets, 2" STI-3100 spacer, STI-3004 Conduit insert and STI-3003 Neoprene conduit gasket.

2.12 PARKING PEDESTAL

2.12.1 Parking pedestal shall be gooseneck construction:

2.12.1.1 Height: 42"

2.12.1.2 Mounting: Pad mounted

2.12.1.3 Material: Cold rolled steel

2.12.1.4 Finish: UV stable black wrinkle powder paint.

2.12.1.5 Product: Viking electronics VE-GNP.

2.12.2 Parking pedestal shall be complete with surface mount gang box. Gang box shall be mounted to the gooseneck parking pedestal. The gang box shall have the following properties:

2.12.2.1 Dimensions: 10"H x 5"W x 3.5"D

2.12.2.2 Material: Cold rolled steel

2.12.2.3 Finish: UV stable black fine texture powder paint.

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2.12.2.4 Product: Viking electronics VE-5x10.

3 **EXECUTION**

3.1 INSTALLATION

- 3.1.1 Support boxes independently of connecting conduits. All boxes to be hung independently of ducts, pipes, etc.
- 3.1.2 Fill boxes with sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- 3.1.3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm ($\frac{1}{4}$ ") of opening.
- 3.1.4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
- 3.1.5 Size boxes in accordance with electrical code.
- 3.1.6 Gang boxes together where wiring devices are grouped.
- 3.1.7 Provide matching blank cover plates for boxes without wiring devices.
- 3.1.8 When using PVC conduit, use approved boxes.
- 3.1.9 Prior to pouring concrete secure flush floor boxes to reinforcing steel, adjust level and to correct height, install cement cover securely. After pour make final adjustments.

END OF SECTION

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Section Name: **Conduit for Electrical Systems**
Section No.: **26 05 33.13**
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1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results – Electrical.
- 1.1.2 Section 26 05 24 – Wiring Methods.
- 1.1.3 Section 26 27 26 – Wiring Devices.
- 1.1.4 Conform to relevant sections of specification for this and other Divisions.

1.2 REFERENCES

- 1.2.1 Canadian Standards Association (CSA).
- 1.2.2 CAN/CSA C22.2 No.18-92, Outlet Boxes, Conduit Boxes, and Fittings.
- 1.2.3 CSA C22.2 No.45-M1981 (R1992), Rigid Metal Conduit.
- 1.2.4 CSA C22.2 No.56-1977 (R1977), Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
- 1.2.5 CSA C22.2 No.83-M1985 (R1992), Electrical Metallic Tubing.
- 1.2.6 CSA C22.2 No.211.2-M1984 (R1992), Rigid PVC (Un-plasticized) Conduit.
- 1.2.7 CAN/CSA C22.2 No.227.3-M91, Flexible Nonmetallic Tubing.

1.3 LOCATION OF CONDUIT

- 1.3.1 The drawings do not show all conduits. Those shown are in diagrammatic form only. Conduits are to be provided to create complete raceway systems.
- 1.3.2 No conduits shall be installed within concrete columns unless specifically approved by the Structural Engineer.

1.4 NUMBER & SIZES OF CONDUITS

- 1.4.1 Conduits to be provided shall be as indicated on documents and/or as required to suit requirements of systems installed.

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2 PRODUCTS

2.1 CONDUITS

- 2.1.1 Rigid metal conduit: to CSA C22.2 No.45, galvanized steel threaded.
- 2.1.2 Epoxy coated conduit: to CSA C22.2 No.45, with zinc coating and corrosion resistant epoxy finish inside and outside.
- 2.1.3 Electrical metallic tubing (EMT): to CSA C22.2 No.83, with couplings.
- 2.1.4 Rigid Schedule 40 PVC conduit of the sizes indicated and required to CSA C22.2 No.211.2-M1984 (R1992).
- 2.1.5 Flexible metal conduit: liquid-tight flexible metal conduit of the sizes indicated and required to CSA C22.2 No.56-1977(R1992).
- 2.1.6 Electrical non-metallic tubing, flexible and flexible liquid-tite included, of the sizes indicated and required to C.S.A. C22.2 No.227.1-1988, No.227.2-M1987 and No.227.3-M91.
- 2.1.7 Do not use conduits smaller than 3/4" unless specifically detailed in these documents.

2.2 CONDUIT FASTENINGS

- 2.2.1 One hole malleable iron, hot dipped galvanized straps to secure surface mounted conduits. Provide complete with properly sized pan head screw.
- 2.2.2 Beam clamps to secure conduits to exposed steel work.
- 2.2.3 Provide 12 gauge galvanized steel "U" channel type supports for two or more conduits on minimum 1500 mm centres. Use suitable conduit clamps in channel.
- 2.2.4 Threaded rods, 6 mm (1/4") dia., to support suspended channels.

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2.3 CONDUIT FITTINGS

- 2.3.1 Fittings: manufactured for use with the conduit specified with the same coating as conduit.
- 2.3.2 Provide insulated bushings on all rigid, threaded conduits.
- 2.3.3 Provide insulated steel set screw connectors and couplings for EMT conduits 2" and smaller.
- 2.3.4 Provide nylon insulated concrete tight steel set screw connectors and couplings for EMT conduits 2" and smaller installed in cast-in-place concrete.
- 2.3.5 Provide nylon insulated steel set screw couplings and connectors for all EMT conduits 2-1/2" and larger.
- 2.3.6 Provide double locknuts and a nylon insulated bushing for Schedule 40 conduit connections to sheet steel boxes and enclosures.
- 2.3.7 Cast Fitting shall not be used on this project.
- 2.3.8 Provide raintight connectors on conduits into the distribution equipment including, but not limited to, switchboards, distribution panels, panelboards, and motor control centres.
- 2.3.9 Provide raintight connectors on conduits in underground parking and parking garages.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

- 2.4.1 Weatherproof expansion fittings with an integral bonding assembly suitable for a 100 (4") mm linear expansion.
- 2.4.2 Watertight expansion fittings with an integral bonding jumper suitable for linear expansion and a 20 mm deflection in all directions.
- 2.4.3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 FISH CORD

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2.5.1 Provide fish cords to be minimum 3 mm polypropylene in all feeder and branch conduit runs.

2.5.2 Provide fish cords to be minimum 3 mm polypropylene in all systems conduit runs.

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

3.1.2 No conduits shall be installed within slabs, columns or concrete walls, unless specifically noted otherwise.

3.1.3 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.

3.1.4 Do not surface mount conduits on building exterior surfaces unless otherwise indicated.

3.1.5 Use rigid PVC or flexible non-metallic tubing (ENT) in cast concrete indoor slab, in accordance with Section 26 05 24 (Wiring Methods).

3.1.6 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

3.1.7 Mechanically bend steel conduit over 19 mm ($\frac{3}{4}$ " dia.

3.1.8 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

3.1.9 Install fish cord in empty conduits.

3.1.10 Run 2-1" spare conduits up to ceiling space from each flush panel. Terminate these conduits in 6" x 6" x 4" (152 mm x 152 mm x 102 mm) junction boxes at top of wall above panel. Box to be selected to suit finish required.

3.1.11 Where conduits become blocked, remove and replace blocked section.

3.1.12 Dry conduits out before installing wire.

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- 3.1.13 Use rigid, threaded Schedule 40, galvanized steel threaded conduit where specified.
- 3.1.14 Use rigid PVC conduit underground for duct bank or otherwise shown within the confines of all applicable codes.
- 3.1.15 Use electrical metallic tubing (EMT) in general areas except in cast concrete and below 2.4 m above finished floor where not subject to mechanical injury.
- 3.1.16 Use flexible metal conduit for connection to motors and transformers, connection to recessed incandescent fixtures without a prewired outlet box, connection to surface or recessed fluorescent fixtures and work in movable metal partitions.
- 3.1.17 Use liquid tight flexible metal conduit for connection to motors, transformers etc.
- 3.1.18 Use flexible conduit (seal tight) connects on line and load side of all transformers.
- 3.1.19 Box offsets must be provided where conduits terminate at a junction box or piece of electrical equipment or distribution.
- 3.1.20 The conduits for the following circuits and systems shall be run separately, except as noted and directed for some low energy systems such as CCTV and intercoms.
 - 3.1.20.1 Normal power to luminaires
 - 3.1.20.2 Emergency power to luminaires
 - 3.1.20.3 Normal power to receptacle outlets
 - 3.1.20.4 Exit lighting system
 - 3.1.20.5 Life safety system
 - 3.1.20.6 Security system
 - 3.1.20.7 Tele/data system
 - 3.1.20.8 A/V system
 - 3.1.20.9 P.A. system wiring
 - 3.1.20.10 CCTV system

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3.1.20.11 Cable TV – AM/FM

3.1.20.12 Intercom system

3.1.20.13 Other auxiliary systems

3.2 PVC CONDUITS

3.2.1 PVC conduits may be bent in the field using approved electrical heating devices or by using the appropriate bends. Damaged or improper bends shall be replaced. All joints shall be made using an approved coupling with solvent welds. Clean all joints with solvent cleaner prior to applying the solvent. Liberally apply the solvent to the conduit fitting, force the conduit into the fitting and rotate the conduit 45 degrees within the flange to form a tight bond. Allow proper curing time.

3.2.2 All scorched PVC conduit shall be removed.

3.3 SURFACE CONDUITS

3.3.1 Run parallel or perpendicular to building lines.

3.3.2 Locate conduits behind infrared or gas fired heaters with 1.5 m (5') clearance.

3.3.3 Run conduits in flanged portion of structural steel.

3.3.4 Group conduits wherever possible on suspended or surface channels.

3.3.5 Do not pass conduits through structural members except as indicated, or approved in writing by the Structural Consultant.

3.3.6 Do not locate conduits less than 75 mm (1 1/8") parallel to steam or hot water lines with minimum of 25 mm (1") at crossovers.

3.4 CONCEALED CONDUITS

3.4.1 Run parallel or perpendicular to building lines.

3.4.2 Do not install horizontal runs in masonry walls and partition.

3.4.3 Do not install conduits in terrazzo or concrete toppings.

3.5 CONDUITS IN CAST-IN-PLACE CONCRETE

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- 3.5.1 Locate to suit reinforcing steel. Install in centre one third of slab.
- 3.5.2 Protect conduits from damage where they stub out of concrete.
- 3.5.3 Install sleeves where conduits pass through slab or wall.
- 3.5.4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.
- 3.5.5 Do not place conduits in slabs in which slab thickness is less than 4 times conduit diameter.
- 3.5.6 Encase conduits completely in concrete with minimum 3" (75mm) concrete cover.
- 3.5.7 Organize conduits in slab to minimize crossovers.
- 3.5.8 Conduits cast-in-concrete shall be installed in accordance with the requirements of the Structural Engineer. Refer to additional details and requirements as noted in the structural drawings.
- 3.6 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE
- 3.6.1 Run conduits 25 mm (1") and larger below slab and encased in 75 mm (3") concrete envelope. Provide 50 mm (2") of sand over concrete envelope below floor slab.
- 3.7 CONDUITS UNDERGROUND
- 3.7.1 Slope conduits away from building to provide drainage.
- 3.7.2 Provide drainage or soak-away pit where conduits enter the building below grade.
- 3.7.3 Waterproof joints (except PVC) with heavy coat of bituminous paint.
- 3.8 EXTERIOR
- 3.8.1 All exterior conduits shall be of rigid PVC or rigid steel.

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Boxes for Electrical Systems**
Section No.: **26 05 33.16**
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1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results for Electrical.
- 1.1.2 Conform to relevant sections of specification for this and other Divisions.

1.2 REFERENCES

- 1.2.1 CSA C22.2 No. 76 – Splitters
- 1.2.2 CSA C22.2 No. 40 – Cutout, Junction, and Pull Boxes

2 **PRODUCTS**

2.1 SPLITTERS

- 2.1.1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- 2.1.2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.
- 2.1.3 At least three (3) spare terminals on each set of lugs in splitters in all splitters

2.2 JUNCTION AND PULL BOXES

- 2.2.1 Welded steel construction with screw-on flat covers for surface mounting.
- 2.2.2 Covers with 25 mm (1") minimum extension all around for flush-mounted junction boxes and pull boxes.

2.3 CABINETS

- 2.3.1 Type E: sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.
- 2.3.2 Type T: sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing 19 mm ($\frac{3}{4}$ ") G1S plywood backboard for surface mounting.

3 **EXECUTION**

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3.1 SPLITTER INSTALLATION

- 3.1.1 Install splitters and mount plumb, true and square to the building lines.
- 3.1.2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- 3.2.1 Install junction boxes and pull boxes in inconspicuous but accessible locations.
- 3.2.2 Mount cabinets with top not higher than 2 m (6' – 6") above finished floor.
- 3.2.3 Install terminal block as indicated in Type T cabinets.
- 3.2.4 Only main junction and pull boxes are indicated on plans. Install pull boxes so as not to exceed 30 m (100') of conduit run or three (3) 90-degree bends between pull boxes.

3.3 IDENTIFICATION

- 3.3.1 Provide equipment identification in accordance with Section 26 05 01 – Common Work Results – Electrical and 26 05 53 - Identification for Electrical Systems.
- 3.3.2 Install size 2 identification labels indicating voltage and phase.

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Surface Raceways for Electrical Systems**
Section No.: **26 05 33.23**
Date: August 30, 2024

1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Comply with the requirements of Section 26 05 00 – Common Work Results – Electrical.
- 1.1.1 Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
- 1.1.2 Section 26 05 24 – Wiring Methods.
- 1.1.3 Conform to relevant sections of specification for this and other Divisions.

1.2 REFERENCES

- 1.2.1 Canadian Standards Association (CSA).
- 1.2.2 CAN/CSA C22.2 No.62-93, Surface Raceway Systems.

1.3 SUBMITTALS

- 1.3.1 Submit shop drawings and product data in accordance with Section 26 05 01.
- 1.3.2 Provide samples of all surface mounted raceways for Consultant's review.

2 **PRODUCTS**

2.1 SURFACE FLOOR RACEWAY SYSTEM

- 2.1.1 Steel: to CSA C22.2 No.62, two-piece, manufactured as lay-in type raceway.
- 2.1.2 Finish: Matte Black
- 2.1.3 Product: Legrand 4000 Series Multi-Channel Metal Raceway.

2.2 FITTINGS

- 2.2.1 Elbows, tees, couplings and hanger fittings: to CSA C22.2 No.62, manufactured as accessories to raceway supplied.

3 **EXECUTION**

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3.1.1 INSTALLATION

3.1.2 Install raceways before installation of wiring. Install covers for raceways and fittings after installation or wiring.

3.1.3 Install supports, elbows, tees, connectors, fittings, bushings, adaptors as required.

3.1.4 Keep number of elbows, offsets, connections to minimum.

3.1.5 Use wiring with mechanical protection in channel raceways.

3.1.6 Install barriers in raceways where different voltage systems are indicated.

END OF SECTION

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Project No.: 2024-0112
Section Name: **Conduits, Conduit Fastening & Conduit Fittings**
Section No.: **26 05 34**
Date: August 30, 2024

1 GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results – Electrical.
- 1.1.2 Section 26 05 24 – Wiring Methods.
- 1.1.3 Section 26 27 26 – Wiring Devices.
- 1.1.4 Conform to relevant sections of specification for this and other Divisions.

1.2 REFERENCES

- 1.2.1 Canadian Standards Association (CSA).
- 1.2.2 CAN/CSA C22.2 No.18-92, Outlet Boxes, Conduit Boxes, and Fittings.
- 1.2.3 CSA C22.2 No.45-M1981 (R1992), Rigid Metal Conduit.
- 1.2.4 CSA C22.2 No.56-1977 (R1977), Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
- 1.2.5 CSA C22.2 No.83-M1985 (R1992), Electrical Metallic Tubing.
- 1.2.6 CSA C22.2 No.211.2-M1984 (R1992), Rigid PVC (Un-plasticized) Conduit.
- 1.2.7 CAN/CSA C22.2 No.227.3-M91, Flexible Nonmetallic Tubing.

1.3 LOCATION OF CONDUIT

- 1.3.1 The drawings do not show all conduits. Those shown are in diagrammatic form only. Conduits are to be provided to create complete raceway systems.
- 1.3.2 No conduits shall be installed within concrete columns.

1.4 NUMBER & SIZES OF CONDUITS

- 1.4.1 Conduits to be provided shall be as indicated on documents and/or as required to suit requirements of systems installed.

2 PRODUCTS

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2.1 CONDUITS

- 2.1.1 Rigid metal conduit: to CSA C22.2 No.45, galvanized steel threaded.
- 2.1.2 Epoxy coated conduit: to CSA C22.2 No.45, with zinc coating and corrosion resistant epoxy finish inside and outside.
- 2.1.3 Electrical metallic tubing (EMT): to CSA C22.2 No.83, with couplings.
- 2.1.4 Rigid Schedule 40 PVC conduit of the sizes indicated and required to CSA C22.2 No.211.2-M1984(R1992).
- 2.1.5 Flexible metal conduit: liquid-tight flexible metal conduit of the sizes indicated and required to CSA C22.2 No.56-1977(R1992).
- 2.1.6 Electrical non-metallic tubing, flexible and flexible liquid-tite included, of the sizes indicated and required to C.S.A. C22.2 No.227.1-1988, No.227.2-M1987 and No.227.3-M91.
- 2.1.7 Do not use conduits smaller than 3/4" unless specifically detailed in these documents.

2.2 CONDUIT FASTENINGS

- 2.2.1 One hole malleable iron, hot dipped galvanized straps to secure surface mounted conduits. Thomas & Betts series 1275 for rigid, threaded conduit and Thomas & Betts Series 4176 for EMT complete with properly sized pan head screw.
- 2.2.2 Beam clamps to secure conduits to exposed steel work.
- 2.2.3 Provide 12 gauge galvanized steel "U" channel type supports for two or more conduits on minimum 1500 mm centres. Use suitable conduit clamps in channel.
- 2.2.4 Threaded rods, 6 mm (1/4") dia., to support suspended channels.

2.3 CONDUIT FITTINGS

- 2.3.1 Fittings: manufactured for use with the conduit specified with the same coating as conduit.
- 2.3.2 Provide insulated bushings on all rigid, threaded conduits.
- 2.3.3 Provide insulated steel set screw connectors and couplings for

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EMT conduits 2" and smaller, Thomas & Betts series.

- 2.3.4 Provide raintight connectors for conduits in all sprinklered areas.
- 2.3.5 Provide nylon insulated concrete tight steel set screw connectors and couplings for EMT conduits 2" and smaller installed in cast-in-place concrete. Thomas & Betts 5031 and 5030 Series.
- 2.3.6 Provide nylon insulated steel set screw couplings and connectors for all EMT conduits 2-1/2" and larger, Thomas & Betts.
- 2.3.7 Provide double locknuts and a nylon insulated bushing for Schedule 40 conduit connections to sheet steel boxes and enclosures.
- 2.3.8 Cast Fitting shall not be used on this project.
- 2.3.9 Provide raintight connectors on conduits into panelboards and MCC's.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

- 2.4.1 Weatherproof expansion fittings with an integral bonding assembly suitable for a 100 (4") mm linear expansion.
- 2.4.2 Watertight expansion fittings with an integral bonding jumper suitable for linear expansion and a 20 mm deflection in all directions.
- 2.4.3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 FISH CORD

- 2.5.1 Provide fish cords to be minimum 3 mm polypropylene in all feeder and branch conduit runs.
- 2.5.2 Provide fish cords to be minimum 3 mm polypropylene in all systems conduit runs.

3 **EXECUTION**

3.1 INSTALLATION

- 3.1.1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

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- 3.1.2 Use rigid PVC DB-2 type 2 (thick walled) or flexible non-metallic tubing (ENT) in cast concrete indoor slab, in accordance with Section 26 05 24 (Wiring Methods).
- 3.1.3 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.
- 3.1.4 Do not surface mount conduits on building exterior surfaces unless otherwise indicated.
- 3.1.5 Use rigid PVC DB-2 type 2 (thick walled) in duct banks. Thin walled PVC conduit will not be accepted.
- 3.1.6 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- 3.1.7 Mechanically bend steel conduit over 19 mm ($\frac{3}{4}$ " dia.
- 3.1.8 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- 3.1.9 Install fish cord in empty conduits.
- 3.1.10 Run 2-1" spare conduits up to ceiling space from each flush panel. Terminate these conduits in 6" x 6" x 4" (152 mm x 152 mm x 102 mm) junction boxes at top of wall above panel. Box to be selected to suit finish required.
- 3.1.11 Where conduits become blocked, remove and replace blocked section.
- 3.1.12 Dry conduits out before installing wire.
- 3.1.13 Use rigid, threaded Schedule 40, galvanized steel threaded conduit where specified.
- 3.1.14 Use rigid PVC conduit underground for duct bank or otherwise shown within the confines of all applicable codes.
- 3.1.15 Use electrical metallic tubing (EMT) in general areas, except in cast concrete, or as indicated otherwise on Construction Documents.
- 3.1.16 Use flexible metal conduit for connection to motors and transformers, connection to recessed incandescent fixtures without a prewired outlet box, connection to surface or recessed fluorescent fixtures and work in movable metal partitions.

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- 3.1.17 Use liquid tight flexible metal conduit for connection to motors, transformers etc.
- 3.1.18 Use flexible conduit (seal tight) connects on line and load side of all transformers.
- 3.1.19 Any nonmetallic raceways installed in concealed space used as a plenum shall meet flame and smoke density rating conforming to FT6 rating when tested in conformance with CAN/ULC-S102.4.
- 3.1.20 Box offsets must be provided where conduits terminate at a junction box or piece of electrical equipment or distribution.
- 3.1.21 The conduits for the following circuits and systems shall be run separately, except as noted and directed for some low energy systems such as CCTV and intercoms.
- 3.1.22 Normal power to luminaires
- 3.1.23 Emergency power to luminaires
- 3.1.24 Normal power to receptacle outlets
- 3.1.25 Exit lighting system
- 3.1.26 Life safety system
- 3.1.27 Security system
- 3.1.28 Tele/data system
- 3.1.29 A/V system
- 3.1.30 P.A. system wiring
- 3.1.31 CCTV system
- 3.1.32 Cable TV – AM/FM
- 3.1.33 Intercom system
- 3.1.34 Other auxiliary systems
- 3.2 PVC CONDUITS
- 3.2.1 PVC conduits may be bent in the field using approved electrical heating devices or by using the appropriate bends. Damaged or improper bends shall be replaced. All joints shall be made using an

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approved coupling with solvent welds. Clean all joints with solvent cleaner prior to applying the solvent. Liberally apply the solvent to the conduit fitting, force the conduit into the fitting and rotate the conduit 45 degrees within the flange to form a tight bond. Allow proper curing time.

3.2.2 All scorched PVC conduit shall be removed.

3.3 SURFACE CONDUITS

3.3.1 Run parallel or perpendicular to building lines.

3.3.2 Locate conduits behind infrared or gas fired heaters with 1.5 m (5') clearance.

3.3.3 Run conduits in flanged portion of structural steel.

3.3.4 Group conduits wherever possible on suspended or surface channels.

3.3.5 Do not pass conduits through structural members except as indicated, or approved in writing by the Structural Consultant.

3.3.6 Do not locate conduits less than 75 mm (1 1/8") parallel to steam or hot water lines with minimum of 25 mm (1") at crossovers.

3.4 CONCEALED CONDUITS

3.4.1 Run parallel or perpendicular to building lines.

3.4.2 Do not install horizontal runs in masonry walls and partition.

3.4.3 Do not install conduits in terrazzo or concrete toppings.

3.5 CONDUITS IN CAST-IN-PLACE CONCRETE

3.5.1 Locate to suit reinforcing steel. Install in centre one third of slab.

3.5.2 Protect conduits from damage where they stub out of concrete.

3.5.3 Install sleeves where conduits pass through slab or wall.

3.5.4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.

3.5.5 Do not place conduits in slabs in which slab thickness is less than

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4 times conduit diameter.

3.5.6 Encase conduits completely in concrete with minimum 3" (75mm) concrete cover.

3.5.7 Organize conduits in slab to minimize crossovers.

3.6 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

3.6.1 Run conduits 25 mm (1") and larger below slab and encased in 75 mm (3") concrete envelope. Provide 50 mm (2") of sand over concrete envelope below floor slab.

3.7 CONDUITS UNDERGROUND

3.7.1 Slope conduits to provide drainage.

3.7.2 Waterproof joints (except PVC) with heavy coat of bituminous paint.

3.8 EXTERIOR

3.8.1 Run conduit to exterior equipment as detailed.

END OF SECTION

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Section Name: **Installation of Cables in Trenches & In Ducts**
Section No.: **26 05 43.01**
Date: August 30, 2024

1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results – Electrical.
- 1.1.2 Conform to relevant sections and specification for this and other Divisions.

2 **PRODUCTS**

3 **EXECUTION**

3.1 CABLE INSTALLATION IN DUCTS

- 3.1.1 Install cables as indicated in ducts.
- 3.1.2 Do not pull spliced cables inside ducts.
- 3.1.3 Install multiple cables in duct simultaneously.
- 3.1.4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- 3.1.5 To facilitate matching of colour coded multi-conductor control cables reel off in same direction during installation.
- 3.1.6 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.
- 3.1.7 After installation of cables, seal duct ends with duct sealing compound.

3.2 FIELD QUALITY CONTROL

- 3.2.1 Perform tests in accordance with Section 26 05 01 – Common Work Results – Electrical.
- 3.2.2 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- 3.2.3 Check phase rotation and identify each phase conductor of each feeder.
- 3.2.4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 mega-

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ohms.

3.2.5 Pre-acceptance Tests.

3.2.5.1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.

3.2.5.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

3.2.6 Acceptance Tests:

3.2.6.1 Ensure that terminations and accessory equipment are disconnected.

3.2.6.2 Ground shields, ground wires, metallic armor and conductors not under test.

3.2.6.3 High Potential (Hipot) Testing:

3.2.6.3.1 Conduct hipot testing in accordance with manufacturer's recommendations.

3.2.6.4 Leakage Current Testing:

3.2.6.4.1 Raise voltage in steps from zero to maximum values as specified by manufacturer for type of cable being tested.

3.2.6.4.2 Record leakage current at each step.

3.2.7 Provide Consultant with list of test results showing.

3.2.8 Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

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Section Name: Identification for Electrical Systems
Section No.: 26 05 53
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1 GENERAL

1.1 REFERENCES AND RELATED SECTIONS

- 1.1.1 Comply with the requirements of Section 26 05 00 – Common Work Results – Electrical.
- 1.1.2 Conform to relevant sections of specification for this and other Divisions.

2 PRODUCTS

2.1 NAMEPLATES

- 2.1.1 Construct all nameplates from laminated plastic having a white core with a black top lamination such that engraving through the top lamination will reveal white lettering on a black background.
- 2.1.2 Construct all warning and emergency power nameplates from laminated plastic having a white core with a red top lamination such that engraving through the top lamination will reveal white lettering on a black background.

2.2 SIZES

- 2.2.1 Provide nameplates of the sizes indicated. Where a size is not given, provide a standard size nameplate of sufficient size to contain the text indicated.
- 2.2.2 Where a numerical size is indicated, provide a nameplate of a size as indicated in the table below. Provide lettering of the height indicated below unless another size is indicated.

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Size	Width (mm)	Height (mm)	First Line lettering height (mm)	Following Lines lettering height (mm)
1	50	25	13	-
1A	50	25	7.5	7.5
2	75	50	13	10
3	75	50	10	7.5
4	100	50	25	10
5	125	75	25	10
6	200	100	25	10

2.2.3 Provide lettering of the height indicated. Where no height is indicated, provide lettering 10 mm high for the first line and 7.5 mm high for all following lines.

2.3 SPECIFIC NAMEPLATES

2.3.1 For each power and distribution transformer, provide a Size 5 nameplate to indicate the following information. The number in brackets indicates the lettering height in millimeters:

2.3.1.1 Line 1: Equipment tag number (25)

2.3.1.2 Line 2: KVA, Rated voltage (10)

2.3.1.3 Line 3: Power source (10)

Example: **TX-2A01**
150KVA 600V-208/120V
FED FROM DP-6A0B

2.3.2 For each panelboard, disconnect switch, loose starter, etc. provide a Size 5 nameplate to indicate the following information. The number in brackets indicates the lettering height in millimeters:

2.3.2.1 Line 1: Equipment tag number (25)

2.3.2.2 Line 2: Rated bus, Rated voltage, phase, and wires (10)

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2.3.2.3 Line 3: Power Source (10)

Example: **PP-2A01**
225A, 208/120V, 3-PH, 4-W
FED FROM DP-2A01

2.4 WARNING NAME PLATES

2.4.1 Type "A", width = 100 mm , height = 100 mm
(Text height in millimetres in brackets)

Text: **DANGER..... (25)**
MORE THAN ONE POWER SOURCE..... (10)
CONTAINED WITHIN,..... (10)
DISCONNECT ALL POWER.....(10)
SOURCES BEFORE SERVICING.....(10)
THIS EQUIPMENT.....(10)

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 Coordinate final nameplate design, colour and nomenclature with the Engineer prior to ordering of nameplates.
- 3.1.2 Install nameplates on the front of the equipment on a prominent flat surface. Attach the nameplates with non-rusting screws.
- 3.1.3 Provide red mimic bus on Medium Voltage equipment and as specified.
- 3.1.4 Provide an Excel spreadsheet with all Nameplates for review by the Owner and the Consultant prior to manufacturing. Submit as a shop drawing.

END OF SECTION

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1 **GENERAL**

1.1 RELATED WORK

1.1.1 Comply with relevant Sections of this and other Divisions of this Specification.

1.2 RELATED SECTIONS

1.2.1 Section 26 05 00 – Common Work Results – Electrical

1.2.2 Section 26 24 13 – Switchboards

1.2.3 Section 26 24 16 – Panelboards

1.2.4 Section 26 25 00 – Enclosed Bus Assemblies

1.2.5 Section 26 28 13 – Fuses – Low Voltage.

1.2.6 Section 26 28 16.13 – Enclosed Circuit Breakers

1.2.7 Section 26 28 16.16 – Enclosed Switches

1.2.8 Conform to relevant sections of specification for this and other Divisions.

1.3 SUMMARY

1.3.1 The short circuit analysis evaluates the adequacy of the electrical equipment to withstand or to interrupt the calculated maximum available short circuit current at its location.

1.3.2 The overcurrent device time-current coordination analysis determines the suggested settings and, where appropriate, the ampere ratings and types for the electrical power system protective devices to achieve the desired system protection and electrical service continuity goals.

1.3.3 The harmonic analysis is performed to provide a baseline model predicting the system's level of harmonic distortion. This information is then to be used to evaluate conformance to IEEE 519.

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- 1.3.4 The arc flash analysis calculates arc flash incident energy, flash protection boundary distances and personal protective equipment (PPE) to be used within the flash protection boundary. This analysis is required to meet CSA Z462 and NFPA 70E requirements.
- 1.3.5 For an existing electrical system, it may be required to perform a field survey to accurately model the analysis. The field survey shall include, but not limited to verification of transformers, meters, fuses, circuit breakers, relays, cable length, impedance and size of conductor, Busway type, etc., as required to perform an accurate analysis.
- 1.3.6 Complete engineering as-built one line diagrams shall be provided using engineering software.
- 1.3.7 The furnishing and the installation of Arc Flash warning labels shall be provided.
- 1.3.8 The company performing the studies shall have at least ten (10) years of experience performing such studies and shall be a registered professional engineer.
- 1.3.9 Studies shall be performed using the latest edition of one of the following software, unless otherwise noted:
 - 1.3.9.1 SKM System Analysis Power
 - 1.3.9.2 ETAP – Electrical Power Systems Analysis
- 1.4 ACCEPTABLE SERVICE PROVIDERS
 - 1.4.1 Acceptable companies to provide coordination study:
 - 1.4.1.1 Brosz and Associates
 - 1.4.1.2 Eastenghouse
 - 1.4.1.3 Enkompass
 - 1.4.1.4 G.T. Wood
 - 1.4.1.5 Pelikan
 - 1.4.1.6 Schneider Electric

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1.4.1.7 Eaton Electric

2 **STUDIES**

2.1 ELECTRICAL POWER SYSTEM STUDIES

2.1.1 An electrical system Coordination and Short Circuit Analysis:

2.1.1.1 Shall compare the calculated maximum fault current with interrupting ratings of overcurrent protective devices such as fuses and circuit breakers.

2.1.1.2 Shall investigate applicable short circuit series ratings and the protection of electrical equipment by current limiting devices.

2.1.1.3 Shall verify the adequacy of other equipment (such as transformers, switches, equipment bussing) to withstand the effects of the calculated maximum fault current levels.

2.1.1.4 Shall assist in the selection and/or determination of settings for relays, fuses and circuit breakers in order to provide best coordination and minimum Arc Flash.

2.1.1.5 Calculate the maximum available rms symmetrical three-phase short-circuit current at each significant location in the electrical system shall be made using a digital computer.

2.1.1.6 Shall simulate a bolted three phase fault at each point of consideration in the system, and calculate the maximum available short circuit current at that point without any reduction due to current limiting overcurrent devices which may be present.

2.1.1.7 Shall include appropriate motor generators and transformer short-circuit contributions (contribution and transformer data) at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.

2.1.1.8 Shall include a tabular computer printout (three phase fault report and fault study summary) which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings.

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- 2.1.1.9 Shall include a computer printout of input circuit data (feeder data) including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
- 2.1.1.10 Shall include a computer printout identifying the maximum available short-circuit current (short circuit comparison tables) in rms symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.
- 2.1.1.11 Shall include a system one-line diagram which is a simplified version of the engineer's drawings showing only those parts of the electrical system under consideration.
- 2.1.2 An Overcurrent Device Time-Current Coordination Analysis is an organized effort to determine the settings and, where appropriate, the ampere ratings and types for the overcurrent protective devices in an electrical system. The objective of the coordination analysis is to effect a time current coordination among the devices which achieves the desired system protection and electrical service continuity goals.
 - 2.1.2.1 The time-current coordination analysis shall be performed with the aid of a digital computer and shall include the determination of settings, ratings, or types for the overcurrent protective devices supplied.
 - 2.1.2.2 Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance.
 - 2.1.2.3 A sufficient number of computer generated log-log plots (time current curves) shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.

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- 2.1.2.4 Computer printouts shall accompany the log-log plots and shall contain descriptions for each of the devices shown, settings of the adjustable devices, short-circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
- 2.1.2.5 The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable overcurrent protective devices.
- 2.1.2.6 Significant deficiencies in protection and/or coordination shall be called to the attention of the owner or designated representative and recommendations made for improvements as soon as they are identified.
- 2.1.3 Arc-Flash Hazard Analysis
 - 2.1.3.1 The Analysis shall be performed with the aid of computer software intended for this purpose in order to calculate Arc-Flash Incident Energy (AFIE) levels and flash protection boundary distances.
 - 2.1.3.2 The Analysis shall be performed in conjunction with a short-circuit analysis and a time-current coordination analysis.
 - 2.1.3.3 Results of the Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.
 - 2.1.3.4 The Analysis shall be performed for minimum and maximum utility short circuit values.
 - 2.1.3.5 Analysis shall be performed upon all electrical equipment connected to transformers sized at 125kVA and above. This procedure is in accordance with IEEE Standard 1584-2018.
 - 2.1.3.6 The Arc-Flash Hazard Analysis shall be performed in compliance with IEEE Standard 1584-2018, the IEEE Guide for Performing Arc-Flash Calculations and NFPA 70E.

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- 2.1.3.7 The Arc-Flash Hazard Analysis shall include recommendations for reducing AFIE levels and enhancing worker safety. One or more additional reiterations of the analysis shall be performed in attempt to lower incident energy levels to desired level in consultation with the Owner and the consultant, but not more than category 2. If the categories cannot be achieved without the change out of existing equipment, recommendations shall be provided for such new equipment to reduce AIFE levels, which may be exercised at the Owner's discretion. The recommendations shall be discussed with the Owner consultant.
- 2.1.3.8 The proposed vendor shall demonstrate experience with Arc-Flash Hazard Analysis.
- 2.1.3.9 The proposed vendor shall demonstrate capabilities in providing equipment, services, and training to reduce Arc-Flash exposure and train workers in accordance with NFPA 70E and other applicable standards.
- 2.1.3.10 The proposed vendor shall demonstrate experience in providing equipment labels in compliance with ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes and must also include the following information
- 2.1.3.10.1 Equipment Name
- 2.1.3.10.2 AFIE flash hazard boundary
- 2.1.3.10.3 AFIE value (cal/cm²)
- 2.1.3.10.4 Hazard Risk Category
- 2.1.3.10.5 System Voltage
- 2.1.3.10.6 Limited Approach Boundary
- 2.1.3.10.7 Restricted Approach Boundary
- 2.1.3.10.8 Prohibited Approach Boundary

END OF SECTION

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1 **GENERAL**

1.1 SUMMARY

1.1.1 Related Documents:

1.1.1.1 Drawings and general provisions of the Contract/ Subcontract apply to this Section, including General and Supplementary conditions and all Division Specifications Sections, apply to this Section.

1.1.1.2 This section covers the Contractor's responsibility for commissioning; each subcontractor or installer responsible for installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item

1.1.1.3 Review these documents for coordination with additional requirements and information that apply to work under this Section.

1.1.1.4 The Commissioning Authority (who will act on behalf of the Owner) scope of work includes the requirements as outlined by LEED CaGBC for New Construction 2009 and the separation in scope is for Fundamental Commissioning and Enhanced Commissioning, as applicable to the project.

1.1.2 Section Includes:

1.1.2.1 This section specifies the unique responsibilities that are a part of, or are related to the commissioning process for the electrical systems. Electrical systems include those listed in Division 01 Section "General Commissioning Requirements" as being commissioned. All statements are the responsibility of the Subcontractor, unless specifically stated otherwise.

1.1.2.2 Electrical testing specified for systems not listed as formally commissioned are not under the commissioning umbrella and are not governed by this section.

1.1.2.3 Electrical Systems Commissioning consists of static checks of component and system installations and review of all electrical testing executed by Authorities Having Jurisdictions / Independent Electrical Testing Authority/ CTC (Certified Testing Company) .

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- 1.1.2.4 Electrical Systems Commissioning consist of testing of monitoring, alarms and communication from the Electrical Systems to other building systems.
- 1.1.2.5 Electrical Systems Commissioning consists of verification of the operation normal and emergency power including but not limited to the resumption of power after power transfers and /or power loss.
- 1.1.2.6 The Commissioning Authority or Owner will review and approve, prior to use, all test procedures and forms used and will witness a varying fraction of the initial checks and testing performed by the Subcontractor. The Commissioning Authority will review the completed check and test documentation of the Subcontractor of all checks and tests.
- 1.1.2.7 Electrical testing requirements are found in various sections in Division 01 and in Division 26 (Division 01 Section "General Commissioning Requirements" and this section). It is not the intent of the commissioning process or these specifications to duplicate efforts or to require the Subcontractor to perform any check or test twice. Checks and testing by the Subcontractor are expected to occur once in the normal sequence of installation and checkout, if appropriate coordination has occurred allowing the Owner and the Commissioning Authority to witness installations and initial testing. Identical electrical checks and testing requirements in both Division 01 and Division 26 are referring to the same event.
- 1.1.2.8 The test requirements listed in this section do not release the Subcontractor from the obligation to perform all other appropriate, industry standard, manufacturer-recommended or code-required checks and tests.
- 1.1.2.9 Testing Participants. The work of this section shall be performed by parties identified in the Check and Testing Responsibility Table-a supplement to Division 01 Section "General Commissioning Requirements". Static checks and testing shall be fully documented according to provisions in Division 01 Section "General Commissioning Requirements".
- 1.1.3 Related Sections:
 - 1.1.3.1 Division 01 Section General Requirements
 - 1.1.3.1.1 Section 01 33 00 Submittal Procedures
 - 1.1.3.1.2 Section 01 33 29 General LEED Requirements

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1.1.3.1.3 Section 01 77 00 Closeout Procedures

1.1.3.1.4 Section 01 78 00 Closeout Submittals

1.1.3.2 Division 26 Electrical Sections

1.2 REFERENCES

1.2.1 General:

1.2.1.1 The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.

1.2.1.2 Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.

1.2.1.3 Refer to Division 01 Section "General Requirements" for the list of applicable regulatory requirements.

1.2.1.4 Refer to Division 23 Section "Common Results for HVAC" for codes and standards, and other general requirements.

1.2.2 Standards:

1.2.2.1 ASHRAE Guideline 0 – The Commissioning Process, 2013

1.2.2.2 ASHRAE Guideline 1.1 – The HVAC&R Technical Requirements for the Commissioning Process, 2012

1.2.2.3 ASHRAE Standard 202 - Commissioning Process for Building and Systems, 2013

1.2.2.4 CSA Z320-11 – Building Commissioning

1.2.2.5 CaGBC LEED V4 BD+C

1.2.2.6 ANSI / NETA Standards

1.2.2.7 Canadian Electrical Safety codes

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1.3 DESCRIPTION

- 1.3.1 The purpose of commissioning is to ensure the Owner that work has been completed as specified and that systems are functioning in the manner as described in Division 26 Section "Common Results for Electrical" and specified system operating criteria. It will assist operating staff training and familiarization with new systems. It will serve as a quality assurance program to reduce post-occupancy critical systems operational difficulty or failure. It will, also, be used to develop test protocol and record the associated test data in an effort to advance the building systems from a state of substantial completion to a full dynamic operation.
- 1.3.2 Commission will commence after startup of equipment and systems have been confirmed as under power, meggered, with confirmed verification of safeties and protective devices.
- 1.3.3 Commissioning work shall include, but not be limited to:
- 1.3.3.1 Attendance at all Commissioning Meetings.
- 1.3.3.2 Preparation of Commissioning Plan.
- 1.3.3.3 Preparation of Commissioning Schedule.
- 1.3.3.4 Development and completion of Commissioning Report forms and check sheets for each system and piece of equipment.
- 1.3.3.5 Demonstration to the Owner and Consultant(s) that the equipment/system have been installed per contract documents.
- 1.3.3.6 Preparation of O&M Manual.
- 1.3.3.7 Preparation of Record Drawings.
- 1.3.3.8 Start-up and verification of systems and equipment.
- 1.3.3.9 Performance testing of equipment.
- 1.3.3.10 Review and verification of Testing, Adjusting and Balancing work and report.
- 1.3.3.11 Correction of all deficiencies and performance deviations.

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- 1.3.3.12 Demonstration and training to Owner and Consultant of all systems and equipment provided in this Division.
- 1.3.3.13 Preparation and assembly of Commissioning Documentation.
- 1.3.3.14 Coordination of Division 23 - HVAC commissioning activities with all other trades.
- 1.3.3.15 Coordinate with and assist Division 21 - Fire Suppression, Division 22 - Plumbing, Division 25 - Integrated Automation, and 26 - Electrical for Commissioning of their respective works.
- 1.3.4 The milestones associated with commissioning are outlined below:
 - 1.3.4.1 Installation Verification
 - 1.3.4.2 System Start-Up.
 - 1.3.4.3 Functional Performance Testing.
 - 1.3.4.4 Issues Review and Retesting
 - 1.3.4.5 Operations and Maintenance Manual Review
 - 1.3.4.6 Building Operations Demonstration and Training
 - 1.3.4.7 Seasonal Testing and Warranty Review (as required)
- 1.3.5 Operational staff training is essential to the commission process and will run concurrently with the commissioning milestones listed above.
- 1.3.6 The Commissioning Team will include representatives of the Owner, Construction and Installing Subcontractors, Test and Balance Subcontractor, FMCS Subcontractor and Construction Subcontractor's Commissioning Agent. Equipment manufacturer's representatives will be present for start-up as specified in the equipment specification sections and for equipment training.
- 1.4 SYSTEMS TO BE COMMISSIONED
 - 1.4.1 Commissioning will be performed on the following systems:
 - 1.4.1.1 Electrical Distribution
 - 1.4.1.1.1 Low-Voltage Electrical Distribution

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- 1.4.1.1.2 Battery Equipment
- 1.4.1.1.3 Transfer Switches
- 1.4.1.2 Lighting and Lighting Controls including Dimming Controls
 - 1.4.1.2.1 Interior Lighting
 - 1.4.1.2.2 Exterior Lighting
 - 1.4.1.2.3 Emergency Lighting
- 1.4.1.3 Underground Ducts and Raceways for Electrical Systems
- 1.4.1.4 Identification of Electrical Systems
- 1.4.1.5 Switchboards
- 1.4.1.6 Panelboards
- 1.4.1.7 Electrical Power Monitoring and Control
- 1.4.1.8 Surge Protective Devices
- 1.4.1.9 Lighting controls
- 1.5 SUBMITTALS
 - 1.5.1 See Section 26 05 00 – Common Work Results, for submittal procedures.
 - 1.5.2 Construction Schedule with Commissioning Milestones
 - 1.5.3 Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.
 - 1.5.4 Calibration certifications of all testing equipment to be used during functional testing period
 - 1.5.5 Equipment Factory Acceptance Tests
 - 1.5.6 Start up and testing procedures
 - 1.5.7 Start-Up Reports including but not limited to Manufacturer Start-Up Reports, prefunctional checklists, pressure and leakage tests, BAS

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point to point verification reports and graphics and TAB reports for CxA Approval and Review.

- 1.5.8 Proof of Coordination of Protective Devices including:
 - 1.5.8.1 Settings of overcurrent trips, relays, circuit breakers, fuses and ground fault
 - 1.5.8.2 Short Circuit Analysis
 - 1.5.8.3 Verification of incoming services
 - 1.5.8.4 Harmonic Studies
 - 1.5.8.5 Megger Tests and associated insulation resistance testing
 - 1.5.8.6 Provide letter from the party who prepared the coordination study that they have confirmed that all settings have been set as per the results of their study.
- 1.5.9 Method of Procedures as required for any required shut-downs for testing
- 1.5.10 Training Requirements, agenda, and schedule
 - 1.5.10.1 Draft Training Plan: In addition to requirements specified in Section 01 79 00, include:
 - 1.5.10.1.1 Follow the recommendations of ASHRAE Guideline 1.
 - 1.5.10.1.2 Control system manufacturer's recommended training.
 - 1.5.10.1.3 Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.
 - 1.5.11 Training Manuals: See Section 01 79 00 for additional requirements.
 - 1.5.11.1 Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.
 - 1.5.12 Operations and Maintenance Manuals
 - 1.5.12.1 Electrical Systems O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the electrical system:

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- 1.5.12.1.1 Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in electrical training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the panel schedules, single line diagrams, and alarms and monitoring points at Control Panels and HMIs
- 1.5.12.1.2 Full as-built set of drawings and single line diagrams.
- 1.5.12.1.3 Full as-built sequence of operations for each piece of equipment.
- 1.5.12.1.4 Full print out of all test and verification reports, and acceptance of the system performed by the Contractor, and / or Certified Testing Company.
- 1.5.12.1.5 Electronic copy on disk of the entire program for this facility.
- 1.5.12.1.6 Maintenance instructions, including calibration requirements, emergency and protective settings.
- 1.5.12.1.7 Warranty requirements.
- 1.6 QUALITY ASSURANCE
- 1.6.1 Qualifications:
 - 1.6.1.1 The CTC (Certified Testing Company) performing the work of this section shall be qualified to test electrical equipment and is a NETA (National Electrical Testing Association)-certified testing agency. The CTC shall not be associated with the manufacturer of equipment or systems under test.
- 1.6.2 Test Equipment:
 - 1.6.2.1 The Subcontractor shall provide all test equipment necessary to fulfill the checks and testing requirements. Test equipment shall have been calibrated within one (1) year of its use on the project.
 - 1.6.2.2 Refer to Division 01 Section "General Commissioning Requirements" for additional requirements.
- 2 **PRODUCTS**
- 2.1 COMMISSIONING PLAN

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2.1.1 The commissioning plan shall outline the organization, scheduling, team members, and documentation pertaining to the overall commissioning process.

2.2 NARRATIVE DESCRIPTIONS

2.2.1 A narrative description of the design intents of the systems and their intended modes of sequences of operation.

2.3 PREFUNCTIONAL CHECKLISTS

2.3.1 Draft Prefunctional Checklists and Functional Test Procedures for Control System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:

2.3.1.1 System name.

2.3.1.2 List of devices.

2.3.1.3 Step-by-step procedures for testing each controller after installation, including:

2.3.1.4 Process of verifying proper hardware and wiring installation.

2.3.1.5 Process of downloading programs to local controllers and verifying that they are addressed correctly.

2.3.1.6 Process of performing operational checks of each controlled component.

2.3.1.7 Plan and process for calibrating valve and damper actuators and all sensors.

2.3.1.8 Description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.

2.3.1.9 Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to specifically indicate when a sensor or controller has “passed” and is operating within the contract parameters.

2.3.1.10 Description of the instrumentation required for testing.

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2.4 FUNCTIONAL TEST PLANS (FTPS)

2.4.1 The FTP procedures at the minimum shall consist of the following sections:

2.4.1.1 Narrative Description:

2.4.1.1.1 This section provides a narrative description of the design intents of the systems and their intended modes of sequences of operation.

2.4.1.2 Testing Prerequisites:

2.4.1.2.1 This section contains verification that primary mechanical, electrical, and controls systems that support or interact with the system that the FTP is prepared against are completed, tested and operational.

2.4.1.3 Installation Verification:

2.4.1.3.1 This section contains verification that the system installation is completed and is ready for commissioning.

2.4.1.4 Commencement of Functional Performance Testing:

2.4.1.4.1 This section records the date and time of the start of system commissioning.

2.4.1.5 System Condition Prior to Starting Performance Testing:

2.4.1.5.1 This section records the current set points and parameters of the system at the start of commissioning.

2.4.1.6 Functional Performance Test:

2.4.1.6.1 This section shall provide the following:

2.4.1.6.1.1 Sequential steps required to set parameters and conditions required to test component and functions throughout intended ranges of operation.

2.4.1.6.1.2 Full range of checks and tests carried out to determine if electric and pneumatic connections, components, subsystems, systems and interfaces between systems function in accordance with the contract documents and design intents.

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2.4.1.6.1.3 All modes and sequences of control operations, interlocks and conditional control responses and specified responses to abnormal emergency conditions.

2.4.1.7 End of Functional Performance Test:

2.4.1.7.1 This section records the date and time of the end of system commissioning.

2.4.1.8 Issue Log:

2.4.1.8.1 This section records notes or remarks during system commissioning.

2.4.1.8.2 List systems modifications, not required by the Contract Documents, but provided by the Subcontractor. List other questions regarding such system modifications.

2.4.1.8.3 List problems discovered during Commissioning that were corrected.

2.4.1.8.4 List problems discovered during Commissioning that were not corrected.

2.4.1.8.5 List recommended party that should take action on these problems.

3 **EXECUTION**

3.1 SUBMITTALS

3.1.1 Submit under provisions of Divisions 01 Section "General Requirements" and "Special Procedures."

3.1.2 Sixty (60) days before any testing is conducted, submit an overall testing plan and schedule for electrical systems that lists the equipment, modes to be tested, dates of testing and parties conducting the tests. Put these tests into the master construction schedule. Keep this plan and schedule updated.

3.1.3 Additional submittal requirements relative to commissioning are found in this Section and in Division 01 Section "General Commissioning Requirements" and Division 01 Section "General Requirements."

3.2 COMMON RESPONSIBILITIES

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- 3.2.1 The following are responsibilities applicable to all electrical systems being commissioned.
- 3.2.2 The general commissioning requirements and coordination are detailed in Division 01 Section "General Commissioning Requirements" and apply to electrical systems. The Subcontractor shall be familiar with all parts of Division 01 Section "General Commissioning Requirements" and the commissioning plan issued by the Commissioning Authority and shall execute all commissioning responsibilities assigned to them in the Contract Documents.
- 3.2.3 The work of this Section shall be performed by a CTC (Certified Testing Company, Electrical), by the EC (Electrical Subcontractor), or the MSR (Manufacturer's Service Representative). The Commissioning Authority has some testing responsibilities for some equipment. The specified checks and static tests are conducted by any of the above listed parties, but the tests requiring measurements or special tools or skills are generally conducted only by the CTC. The Check and Testing Responsibility Table, included as a supplement to Division 01 Section "General Commissioning Requirements" provides specific allocation of checklist oversight and testing responsibilities. The CTC, EC, and MSR shall document all checks and testing on check and test procedure forms submitted to and approved by the Commissioning Authority prior to testing.

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- 3.2.4 The Subcontractor shall notify the Owner ahead of time when commissioning activities not yet performed or not yet scheduled will delay construction. The Subcontractor shall be proactive in seeing that commissioning processes are executed and that the CA has the scheduling information needed to efficiently execute the commissioning process.
- 3.2.5 The Subcontractor shall respond to notices of issues identified during the commissioning process, making required corrections or clarifications and returning prompt notification to the Commissioning Authority according to the process given in Division 01 Section "General Commissioning Requirements".
- 3.2.6 When completion of a task or other issue has been identified as holding up any commissioning process, particularly functional testing, the Subcontractor shall, within two (2) days of notification of the issue, notify the Commissioning Authority in writing providing an expected date of completion. The Subcontractor shall notify the Commissioning Authority in writing within one day of completion. It is not the responsibility of the Commissioning Authority to obtain this status information through meeting attendance, asking questions or field observation
- 3.2.7 Construction Checklists. The Commissioning Authority or Subcontractor shall develop checklists as noted in the list of commissioned systems in Division 01 Section "General Commissioning Requirements", following the process described in Division 01 Section "General Commissioning Requirements" and in this Section. At a minimum, for a given piece of equipment, checks from the inspection checklists in NETA Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems shall be included in the electrical checklists. The Subcontractor shall execute and document all checks.
- 3.2.8 Check and testing procedure and startup plan development and execution responsibilities are described in the Check and Testing Responsibility Table in the supplements to Division 01 Section "General Commissioning Requirements".
- 3.2.9 The Subcontractor shall review design documents, shop drawings and O&M manuals and manufacturer recommended installation and testing procedures of each system installation.

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- 3.2.10 The Subcontractor shall monitor installation to ensure the equipment, configuration and quality of construction meets the design requirements, approved submittals and shop drawings.
- 3.2.11 The Subcontractor shall develop test procedures and forms and execute and document testing according to the requirements of this Section, Division 01 Section "General Commissioning Requirements" and other specification sections containing testing requirements.
- 3.2.12 Tests of energized equipment shall be conducted when the equipment is operating at its normal capacity. This may require some tests to be conducted after occupancy.
- 3.2.13 Training and Orientation. The Subcontractor shall follow the facility staff orientation and training requirements as described in Division 01 Section "Demonstration and Training" and other applicable technical sections.
- 3.2.14 Operation And Maintenance (O&M) Manuals. Refer to Division 01 Section "General Commissioning Requirements" and Division 01 Section "General Requirements" for requirements for O&M manuals.

4 **EQUIPMENT-SPECIFIC VERIFICATION AND TESTING REQUIREMENTS**

4.1 SUMMARY

- 4.1.1 This Part specifies the check and testing requirements for electrical components and systems. From these requirements, the Commissioning Authority or Subcontractor will develop detailed procedures and forms. The general testing process, requirements and test method definitions are described in Division 01 Section "General Commissioning Requirements".

4.2 CHECKS AND TESTS

- 4.2.1 Checks are intended to begin upon completion of a component or equipment installation. Testing generally occurs later when systems are energized or nearing that point. Beginning system testing before full completion, does not relieve the Subcontractor from fully completing the system as soon as possible, including all construction checklists and may require retesting portions of the system once all components are fully functioning.

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- 4.2.2 Refer to Division 01 Section "General Commissioning Requirements" for specific details on non-conformance issues relating to construction checklists and tests. Refer to Division 01 Section "General Commissioning Requirements", for common requirements of deferred testing and to articles in this Section.
- 4.2.3 The check and test procedures and record forms shall contain the following:
 - 4.2.3.1 The Subcontractors executing the checks or tests.
 - 4.2.3.2 A list of the integral components being inspected and tested, equipment tag numbers, manufacturer, model number, pertinent performance information / rating data.
 - 4.2.3.3 Test equipment used.
 - 4.2.3.4 Construction checklists associated with the components, if any.
 - 4.2.3.5 Any special required conditions of the check or test for each procedure.
 - 4.2.3.6 Items, conditions or functions to be inspected, verified or tested, the checks and testing method given and a place provided with results recorded.
 - 4.2.3.7 Acceptance criteria (or reference by specific table where the acceptance criteria is found).
 - 4.2.3.8 For each procedure, list the technician performing check or test and company, witnesses of the tests and dates of tests.
 - 4.2.3.9 Sampling strategies used.
- 4.2.4 The test procedures for dynamic equipment like lighting controls, emergency generator or fire alarm shall contain more step-by-step procedures with expected responses similar to the sample test provided as a supplement to Division 01 Section "General Commissioning Requirements". The test procedures and forms for more static components like panel boards, switch gear, circuit breakers, transformers, etc., can be more checklist-like in format. For each piece of equipment, checks and test procedures and their documentation record forms may be different documents or combined in the same document, but checks and tests should be grouped.

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4.2.5 At the Commissioning Authority's discretion, if large numbers or repeated deficiencies are encountered, the Subcontractor shall test and troubleshoot all remaining systems at issue on their own before commissioning with the Commissioning Authority will resume.

4.2.6 Sampling for Identical Units. When there are a number of identical units, at the Commissioning Authority's discretion, some or all procedures of a test for a piece of equipment or assembly may be omitted when these same tests on other pieces of identical equipment or assemblies were conducted without deficiency.

4.3 EQUIPMENT-SPECIFIC TESTING REQUIREMENTS

4.3.1 The following paragraphs define the testing requirements for each type of system or feature that is a part of the project. The Commissioning Authority shall use this information to develop specific testing procedures for each of the systems to be commissioned. The Subcontractor shall be responsible for support, execution and coordination of these tests as described in the project specifications including intersystem tests and interlocks with systems in Divisions other than Division 26.

4.3.2 The Commissioning Authority and Subcontractor shall coordinate with the project LEED coordinator to verify that LEED requirements for testing electrical systems are included in the tests.

4.3.3 Common Testing Requirements

4.3.3.1 The following requirements apply to all electrical systems and features that are to be commissioned when referenced below. Tests shall:

4.3.3.1.1 Verify functionality and compliance with the design intent for each individual sequence module in the sequences of operation. Verify proper operation of all control strategies, energy efficiency and self-diagnostics features by stepping through each sequence and documenting equipment and system performance. Test every step in every written sequence and other significant modes, sequences and operational features not mentioned in written sequences; including startup, normal operation, shutdown, scheduled on and off, unoccupied and manual modes, safeties, alarms, over-rides, lockouts and power failure.

4.3.3.1.2 Verify all alarm and high and low limit functions and messages generated on all points with alarm settings.

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- 4.3.3.1.3 Verify integrated performance of all components and control system components, including all interlocks and interactions with other equipment and systems.
- 4.3.3.1.4 Verify shut down and restart capabilities both for scheduled and unscheduled events (e.g. power failure recovery and normal scheduled start/stop).
- 4.3.3.1.5 When applicable, demonstrate a full cycle from off to on and no load to full load and then to no load and off.
- 4.3.3.1.6 Verify time of day schedules and setpoints.
- 4.3.3.1.7 Verify all energy saving control strategies.
- 4.3.3.1.8 Verify that monitoring system graphics are representative of the systems and that all points and control elements are in the same location on the graphic as they are in the field.
- 4.3.3.1.9 Verify operator control of all commandable control system points including proper security level access.
- 4.3.3.1.10 When testing procedures for commissioned equipment are listed in NETA Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems the NETA test procedures shall be part of the testing requirements of this specification. Additional testing procedures may be listed in this specification.
- 4.3.3.1.11 Common Acceptance Criteria
- 4.3.3.2 The following common acceptance criteria apply to all mechanical equipment, assemblies and features:
 - 4.3.3.2.1 For the conditions, sequences and modes tested, the equipment, integral components and related equipment shall respond to varying loads and changing conditions and parameters appropriately as expected, according to the sequences of operation, as specified, according to acceptable operating practice and the manufacturer's performance specifications. Verify that equipment operates within tolerances specified in: governing codes, acceptance criteria contained in the construction documents, manufacturer's literature and according to good operating practice.

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- 4.3.3.2.2 Systems shall accomplish their intended function and performance.
- 4.3.3.2.3 All safety trips shall require a manual reset to allow a system restart.
- 4.3.3.2.4 Resetting a manual safety shall result in a stable, safe, and predictable return to normal operation by the system.
- 4.3.3.2.5 Safety circuits and permissive control circuits shall function in all possible combinations of selector switch positions (hand, auto, inverter, bypass, etc.).
- 4.3.3.2.6 Other acceptance criteria is given in the equipment testing requirements articles or referenced standards.
- 4.3.3.2.7 Additional acceptance criteria will be developed by the Commissioning Authority when detailed test procedures are developed.
- 4.3.3.2.8 When testing procedures for commissioned equipment are listed in NETA Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems the NETA performance criteria shall apply.
- 4.3.4 Equipment-Specific Testing Requirements:
 - 4.3.4.1 Scheduled Lighting Controls.
 - 4.3.4.1.1 Apply the applicable common testing requirements and acceptance criteria.
 - 4.3.4.1.2 Test Methods. Utilize active testing, and trending when available. If able to trend, trend all zones over a week period and follow the trending guidelines in Division 23 Section "Commissioning of HVAC".
 - 4.3.4.1.3 Sampling Strategy. Manually test 20 percent of the zones or at least four. If more than 10 percent or two zones fail, test another 10 percent sample. If the second sample fails the Subcontractor shall document retesting on all zones on their own using a Commissioning Authority approved form.
 - 4.3.4.2 Occupancy Sensor Lighting Controls.

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- 4.3.4.2.1 Apply applicable common testing requirements and acceptance criteria. Test all the units functions, including sensor sensitivity and time-to-OFF functions and ensure that sensor location is proper and won't be tripped inadvertently by other occupants and movements outdoors, etc.
- 4.3.5 Test Methods. Utilize active test methods.
- 4.3.5.1 Sampling Strategy. Test 10 percent of the sensors or six, whichever is greater. If more than 10 percent or two sensors fail, test another 10 percent sample. If the second sample fails the Subcontractor shall document retesting on all units on their own using a Commissioning Authority approved form.
- 4.3.5.2 Additional Acceptance Criteria. Reasonable sensitivity, no inadvertent trips, lights go off within 15 seconds of design.
- 4.3.5.3 Emergency Generator System
 - 4.3.5.3.1 Apply applicable common testing requirements and acceptance criteria.
 - 4.3.5.3.2 Test according to NETA 7.22.1 and NFPA 110 5.13 and per Division 01 Section "Special Procedures."
 - 4.3.5.3.3 Record all data and results.
 - 4.3.5.3.4 Include the following tests:
 - 4.3.5.3.4.1 When in enclosed spaces, verify combustion and ventilation air damper functions and pressure drop of exhaust.
 - 4.3.5.3.4.2 Verify fuel oil system, diesel fuel storage tank, and level and low fuel indication alarms.
 - 4.3.5.3.4.3 Verify all alarms, meters, and auxiliaries and interlocks to the BAS.
 - 4.3.5.3.5 Building Test. Under a cold generator condition, provide full utility power interruption under load and cause emergency power service operation. Include all UPS in this test. Load bank the UPS if necessary during test.
 - 4.3.5.3.6 Verify all generator functions
 - 4.3.5.3.7 Test auto-transfer switch operation under actual voltage drop, per specification Division 26 Section "Automatic Transfer Switch with Bypass-Isolation Feature".

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- 4.3.5.3.8 Using a power line disturbance monitor, measure the following times: power failure to engine start command, engine start command to engine start (cranking time), engine start to point where generator is at proper volts and frequency and total time from power failure until ATS switches.
- 4.3.5.3.9 Verify system reporting & control monitoring point-to-point
- 4.3.5.3.10 Verify that each circuit and equipment served by emergency power, does power up. Verify all functions of the Emergency Power Response Matrix.
- 4.3.5.3.11 Verify appropriate mechanical system and control system restart functions of all equipment served by the generator.
- 4.3.5.4 Step Load Tests.
- 4.3.5.4.1 Test at 0 percent, 25 percent, 50 percent and 100 percent of full load. Measure voltage and frequency and record all gaged engine conditions. The test shall consist of running the engine-generator while connected to the resistive load bank for one hour, and then shutting down for 30 minutes.
- 4.3.5.4.2 Test for multiple generator starts.
- 4.3.5.4.3 Verify all operational data and start-up minimum time interval.
- 4.3.5.4.4 Verify 2-hour full load run full load bank (building load can serve as part of the load).
- 4.3.5.4.5 Verify all generator-running characteristics.
- 4.3.5.4.6 Verify battery-charging system.
- 4.3.5.5 Fire Alarm.
- 4.3.5.5.1 Apply applicable common testing requirements and acceptance criteria.
- 4.3.5.5.2 Test the fire alarm and High Sensitivity Smoke Detection systems according to NFPA 110-1999 7-1 through 7-2, and specification Division 28 Sections "High Sensitivity Air Sampling Smoke Detection System" and "MXL Fire Detection & Alarm System".
- 4.3.5.5.3 Document all test procedures and results. A fire alarms system printout of the test annunciation record is not sufficient documentation.

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- 4.3.5.5.4 Verify all fire alarm panel functions, alarms and troubles.
- 4.3.5.5.5 Verify all functions in the Fire Alarm Response Matrix, including remote communications.
- 4.3.5.5.6 Verify resetting of all equipment affected by an alarm.
- 4.3.5.5.7 Sampling Strategy. Verify device functions and annunciations per using the approved sampling rate of the authority having jurisdiction and per LBNL.

END OF SECTION

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1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results – Electrical.
- 1.1.2 Section 26 27 26 – Wiring Devices.
- 1.1.3 Conform to relevant sections of specification for this and other Divisions.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- 1.2.1 Submit shop drawings and product data in accordance with Section
- 1.2.2 26 05 00 – Common Work Results – Electrical.
- 1.2.3 Samples: Samples of specified devices upon request.

2 **PRODUCTS**

2.1 POWER PANELS

- 2.1.1 Mechanical:
 - 2.1.1.1 Listed to UL 508 as industrial control equipment. CSA certified, or NOM approved as applicable.
- 2.1.2 Delivered and installed as a CSA listed factory assembled panel.
- 2.1.3 Field wiring accessible from front of panel without need to remove dimmer assemblies or other components.
- 2.1.4 Ship panels with each dimmer in mechanical bypass position by means of jumper bar inserted between input and load terminals. Jumpers to carry full rated load current and be reusable at any time. Mechanical bypass device to allow for switching operation of connected load with dimmer removed by means of circuit breaker.
- 2.1.5 Electrical
 - 2.1.5.1 Panels contain branch circuit protection for each input circuit unless the panel is a dedicated feed-through type panel or otherwise indicated on the drawings.
 - 2.1.5.2 Branch circuit breakers; meet following performance requirements:

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- 2.1.5.2.1 Listed to UL 489 as molded case circuit breaker for use on lighting circuits.
- 2.1.5.2.2 Contain visual trip indicator; rated at 10,000 AIC, 120 V Dimming.
- 2.1.5.2.3 Thermal-magnetic construction for overload, short-circuit, and over-temperature protection. Use of breakers without thermal protection requires dimmers/relays to have integral thermal protection to prevent failures when overloaded or ambient temperature is above rating of panel.
- 2.1.5.2.4 Accept tag-out/lock-out devices to secure circuit breakers in off position when servicing loads.
- 2.1.5.2.5 Replaceable without moving or replacing dimmer/relay assemblies or other components in panel. UL listed as switch duty (SWD) so that loads can be switched on and off by breakers.
- 2.1.5.3 Minimum UL listed Short Circuit Current Rating (SCCR) of 25,000A.
- 2.1.6 LCD Panel Processor:
 - 2.1.6.1 Separate password protection for installer and end user system settings.
 - 2.1.6.2 Language selection: English.
 - 2.1.6.3 Integral contact closure inputs.
 - 2.1.6.4 Programming and system operation:
 - 2.1.6.4.1 Time clock
 - Integral astronomical time clock
 - Selectable geographic location (city or latitude/longitude).
 - Selectable time zone.
 - Selectable date and time format.
 - Adjustable starting and ending of daylight savings time.
 - Schedule adjustable to add, copy, modify, view, and delete events.

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- Assign functionality to time clock events:

- 2.1.6.4.2 Select global scene
- 2.1.6.4.3 Select customized scene
- 2.1.6.4.4 Enable/Disable all control stations (keypads)
- 2.1.6.4.5 Initiate delay to off
- 2.1.6.4.6 Enable/disable after hours mode
- 2.1.6.5 Shut off sequence can be delayed by button press or occupancy sensor override for 30 minutes.
 - 2.1.6.5.1 Repeat shut off sequence after the delay period.
 - 2.1.6.5.2 Global Scene: Set and recall scene programming for multiple wall station locations.
- 2.1.7 Overrides:
 - 2.1.7.1 Enable/disable time clock
 - 2.1.7.2 Enable/disable all control stations
 - 2.1.7.3 Enable/disable after-hours
- 2.1.8 Diagnostics and Service:
 - 2.1.8.1 Replacing dimmer/relay does not require re-programming of system or processor.
 - 2.1.8.2 Dimmers/relays: Include diagnostic LED's to verify proper operation and assist in system troubleshooting.
 - 2.1.8.3 Dimming/relay panels: Include tiered control scheme for dealing with component failure that minimizes loss of control for occupant.
 - 2.1.8.4 If lighting control system fails, lights to remain at current level. Panel processor provides local control of lights until system is repaired.
 - 2.1.8.5 If panel processor fails, lights to remain at current level. Circuit breakers can be used to turn lights off or to full light output, allowing non-dim control of lights until panel processor is repaired.

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2.1.8.6 If dimmer fails, factory-installed mechanical bypass jumpers to allow each dimmer to be mechanically bypassed. Mechanical bypass device to allow for switching operation of connected load with dimmer removed by means of circuit breaker.

2.2 GENERAL – 0-10V DIMMERS

2.2.1 These products shall be coordinated with switching devices in Section 26 27 26 which must be in the same line up and have similar appearances.

2.2.2 Provide linear slide dimmer controls: specifically for the required loads (i.e. incandescent, fluorescent, magnetic low voltage, electronic low voltage). All devices shall be CSA listed.

2.2.3 The dimmers shall provide a smooth and continuous Square-Law Dimming curve, calibrated linear slide control, Air Gap off switch, voltage compensation circuitry and utilize a filter network to minimize interference from partially installed radio, audio, and video equipment.

2.2.4 Dimmer numbers are based on Lutron.

2.2.5 Fluorescent Dimmer (0-10V)

2.2.5.1 Dimmer shall have direct control of fluorescent dimming ballast up to the ballast manufacturer's specified rating.

2.2.5.2 Dimmers shall not void warranty of fixture manufacturer.

2.2.5.3 Dimmer shall be rated for minimum load of 300W.

2.2.5.4 Dimmer shall be complete with power pack, as required, to allow for control of 347V ballasts

2.2.5.5 Lutron DIVA DDTV or equivalent.

2.2.6 Acceptable Manufacturers:

2.2.6.1 Product to be selected as part of the Design Assist process. Electrical Contractor to submit shop drawing indicating manufacturer as per the Design Assist coordination.

2.3 GENERAL – OCCUPANCY SENSORS

2.3.1 Sensor Type: 360° Dual Technology Occupancy Sensors

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- 2.3.1.1 The dual technology sensor shall be capable of detecting presence in the control area by detecting Doppler shifts in transmitted ultrasound and passive infrared heat changes.
- 2.3.1.2 Sensors shall use patent pending ultrasonic diffusion technology that spreads coverage to a wider area.
- 2.3.1.3 Sensors shall utilize dual sensing verification principle for coordination between ultrasonic and PIR technologies. Detection verification of both technologies must occur in order to activated lighting systems. Upon verification, detection by either shall hold lighting on.
- 2.3.1.4 Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off.
- 2.3.1.5 Sensors shall be mounted to the ceiling with a flat, unobtrusive appearance and provide 360° of coverage.
- 2.3.1.6 Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 KHz. It shall utilize Advanced Signal Processing which automatically adjusts the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.
- 2.3.1.7 To avoid false ON activations and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.
- 2.3.1.8 The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall be Poly IR4 material to offer superior performance in the infrared wavelengths and filter short wavelength IR, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.
- 2.3.1.9 Sensors shall operate at 24VDC/VAC and halfwave rectified and utilize a Watt Stopper power pack.
- 2.3.1.10 Sensors shall have a fixed time delay of 5 to 30 minutes, set by DIP switch.
- 2.3.1.11 Sensors shall feature a walk-through mode, where lights turn off 3

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minutes after the area is initially occupied if no motion is detected after the first 30 seconds.

- 2.3.1.12 The DT-300 sensors shall have a built-in light level sensor that works from 30 to 300 footcandles.
- 2.3.1.13 The DT-300 and DT-305 sensors shall have a manual on function that is facilitated by installing a momentary switch.
- 2.3.1.14 Sensors shall have eight occupancy logic options that give the ability to customize control to meet application needs.
- 2.3.1.15 The sensors shall feature terminal style wiring, which makes installation easier.
- 2.3.1.16 DT-300 sensor shall have an additional single-pole, double throw isolated relay with normally open, normally closed and common outputs. The isolated relay is for use with HVAC control, data logging, and other control options.
- 2.3.1.17 Each sensing technology shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled for applications that require less sensor visibility.
- 2.3.1.18 To ensure quality and reliability, sensor shall be manufactured by an ISP 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.
- 2.3.1.19 Sensors shall have standard 5 year warranty and shall be UL and CUL listed.
- 2.3.1.20 Provide low voltage power pack as required for sensor operation.
- 2.3.2 Automatic Wall Switch Sensor:
 - 2.3.2.1 The passive infrared sensor shall be a completely self-contained control system that replaces a standard toggle switch. Switching mechanism shall be a latching air gap relay, compatible with electronic ballasts, compact fluorescent and inductive loads. Triac and other harmonic generating devices shall not be allowed. Sensor shall have ground wire and grounded strap for safety.
 - 2.3.2.2 Sensor shall be capable of detecting presence in the control area by detecting changes in infrared energy. Small movements shall be detected, such as when a person is writing while seated at a desk.

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- 2.3.2.3 Detection Signature Processing (DSP) shall be used to avoid false offs and false activations and to provide immunity to RFI and EMI.
- 2.3.2.4 Continuously adjusting Zero Cross relay control shall be used to guarantee reliable operation with non-linear loads (electronic, PL lamp ballasts) even with temperature changes and product aging.
- 2.3.2.5 Sensor shall have a fixed time delay of 5, 10, 15, 20 or 30 minutes, walk-through mode, or test mode, set by DIP switch, In walk-through mode, lights shall turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.
- 2.3.2.6 Sensor shall have the choice of light flash alert and/or audible alert of impending light shut off, selectable with DIP switch.
- 2.3.2.7 Sensor shall have sensitivity adjustment that is set with DIP switch.
- 2.3.2.8 Sensor shall have a built-in light level feature selectable with DIP switch.
- 2.3.2.9 Sensor shall have automatic-ON or manual-ON operation adjustable with DIP switch.
- 2.3.2.10 Sensor shall have no minimum load requirement.
- 2.3.2.11 Sensor shall utilize a temperature compensated, dual element sensor, and a multi-element Fresnel lens.
- 2.3.2.12 For vandal resistance, Fresnel lens shall be made of hard, 1.0mm Poly IR 2 material that offers protection against direct impact. Lens shall have grooves facing in to avoid dust and residue build up which affects IR reception
- 2.3.2.13 Sensitivity to motion and detection performance. Lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.
- 2.3.2.14 Sensor shall cover up to 300 sq ft for walking motion, with a field of view of 180 degrees.
- 2.3.2.15 Adjustments and mounting hardware shall be concealed under a removable, tamper resistant cover to prevent tampering of adjustments and hardware.
- 2.3.2.16 Sensor shall have a 100% off switch with no leakage current to the load.

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2.3.2.17 Sensor shall not protrude more than 3/8" from the wall and shall blend in aesthetically.

2.3.3 Acceptable Manufacturers:

2.3.3.1 All sensors shall be of one manufacturer. Provide lighting control devices from one of the following approved manufacturers:

2.3.3.1.1 Watt Stopper

2.3.3.1.2 Sensor Switch

2.3.3.2 Lutron

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 It shall be the Contractor's responsibility to locate and aim sensory in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The Contractor shall provide additional sensors if required to properly and completely cover the respective room.

3.1.2 It is the Contractor's responsibility to arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the Owner's facility, to verify placement of sensors and installation criteria.

3.1.3 Proper judgement must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. The Contractor shall also provide, at the Owner's facility, training to the owner's personnel in the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.

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END OF SECTION

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1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results – Electrical.
- 1.1.2 Section 26 05 24 – Wiring Methods.
- 1.1.3 Section 26 05 28 – Grounding – Secondary.
- 1.1.4 Section 26 05 29 – Hangers & Supports.
- 1.1.5 Section 26 05 53 – Identification For Electrical Systems
- 1.1.6 Section 26 05 73 – Short Circuit, System Coordination, Arc Flash Study.
- 1.1.7 Conform to relevant sections of specification for this and other Divisions.

1.2 STANDARDS

- 1.2.1 Design, manufacture and test the dry type transformers in accordance with good industry practice and in accordance with the following Standards:
 - 1.2.1.1 CSA C22.2 No.47 and CSA C9 – Dry Type Transformers.
 - 1.2.1.2 CSA 802.2-12 Standard. – Minimum efficiency values for dry type transformer.
 - 1.2.1.3 NEMA- ST-20
 - 1.2.1.4 ANSI 57.12.01 General requirements of dry type distribution & power transformers.

1.3 PRODUCT DATA & SHOP DRAWINGS

- 1.3.1 Submit product data in accordance with Section 26 05 00 – Common Work Results – Electrical. This shall include dimensions, weight, electrical performance %Z, X/R, Inrush current, no load loss, load loss.

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1.4 SOURCE QUALITY CONTROL

- 1.4.1 Submit full production test data per CSA- C9 Standard for each KVA rating to engineer for review. Units shall not be shipped until this process is complete.
- 1.4.2 Owner reserves the right to verify test data at site by third party.

2 **PRODUCTS**

2.1 TRANSFORMERS

- 2.1.1 Transformers with primary windings shall have the following characteristics:
- 2.1.1.1 Voltage and kVA ratings as indicated.
- 2.1.1.2 Single or three phase as indicated.
- 2.1.1.3 Delta connected for three phase transformers as indicated.
- 2.1.1.4 1.2 kV insulation class with standard B.I.L.
- 2.1.1.5 Four 2 1/2% taps, 2 FCAN and 2 FCBN.
- 2.1.2 Transformers with secondary windings shall have the following characteristics:
- 2.1.2.1 Voltage rating as indicated.
- 2.1.2.2 Wye connected for three phase transformers as indicated on the drawing.
- 2.1.3 Provide full width electrostatic shield resulting in a maximum effective coupling capacitance between the primary and secondary of 33 picofarads. The shield shall be located in the windings to increase the electrical noise attenuation. Terminate the shields at an isolated terminal in the terminal connection area.
- 2.1.4 Transformers shall have the following characteristics:
- 2.1.4.1 Unless specifically noted otherwise, provide K-4 rated transformer as minimum.

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2.1.4.3

2.1.4.4 The transformers shall be K-13 rated transformers, where indicated.

2.1.4.5 Transformer windings shall be copper.

2.1.4.6 Transformers shall be specifically designed to supply 100% of the 60hz fundamental rated current, 33% of the fundamental current as third harmonic, 20% of the fundamental current as fifth harmonic, 14% of the fundamental current as seventh harmonic, 11% of the fundamental current as ninth harmonic, and lower proportional percentages of the fundamental current through the 25th harmonic.

2.1.4.7 Transformers shall be marked with a label stating 'Suitable for Non-Sinusoidal Current Load with K factor not to exceed 13.

2.1.4.8 Type ANN

2.1.4.9 Class 220 C insulation. Neither the primary nor the secondary temperature shall exceed the 220 C at any point in the coils while carrying their full load.

2.1.4.10 115 degree C temperature rise.

2.1.4.11 Vacuum impregnated polyester resin construction.

2.1.4.12 Transformer to be suitable for loads with crest factor up to 4.5 and capable to deliver full nameplate kVA for loads of up to K-factor of 13, without exceeding 115 C° temperature rise.

2.1.4.13 Standard hipot level.

2.1.4.14 A core constructed of laminations of high permeability silicon steel M6 or better grade and visibly grounded to the enclosure by means of a flexible grounding conductor, sized in accordance with applicable standards. It shall be designed with low hysteresis and eddy current losses.

2.1.4.15 No load excitation currents shall be less than 5% up to 75 kVA. & less than 4% above 75 kVA. No load losses can exceed 0.36% to 0.4% of nameplate rating.

2.1.4.16 Transformer Sound Level:

2.1.4.16.1 Up to 9 kVA: 40 dB average

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- 2.1.4.16.2 10 kVA – 50 kVA: 45 dB average
- 2.1.4.16.3 51 kVA – 150 kVA: 50dB average
- 2.1.4.16.4 151 kVA – 300 kVA: 55 dB average
- 2.1.4.16.5 Above 301 kVA: 60db average.
- 2.1.4.17 Transformer to withstand available short circuit level.
- 2.1.4.18 Impedance:
 - 2.1.4.18.1 3% min., 4.5% max. up to & including 112.5 kVA
 - 2.1.4.18.2 4% min, 5% max 150 to 225 kVA
 - 2.1.4.18.3 5% min, 6% max 300 & 500 kVA
- 2.1.4.19 Neutral Connections:
 - 2.1.4.19.1 Neutral connection to be rated at twice the ampacity of the secondary phase current.
 - 2.1.4.19.2 The 200% neutral ampacity to be established at the star point of the transfer coils and extended through to the neutral connection to the Contractor's field wiring.
- 2.1.4.20 Transformer Enclosures:
 - 2.1.4.20.1 CSA enclosure 1, sprinklerproof with removable front cover.
 - 2.1.4.20.2 Acid etch the enclosure, prime with zinc chromate primer and apply 2 finish coats of enamel. Transformers with manufacturer's standard grey.
 - 2.1.4.20.3 Manufacturer to provide quart of touch-up paint or several pressurized spray cans to touch-up small marred during installation.
 - 2.1.4.20.4 A front accessible terminal compartment at the bottom of the enclosure suitable for 90 degrees C rated conductors (ampacity corresponding to 75 degree).
 - 2.1.4.20.5 Vibration dampers between the frame and the core and coils assembly.
 - 2.1.4.20.6 Bolted type off load tap changer.

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- 2.1.4.21 A nameplate shall be affixed to the enclosure indicating, but not restricted to the following:
 - 2.1.4.21.1 Voltage ratings
 - 2.1.4.21.2 kVA rating
 - 2.1.4.21.3 Impedance
 - 2.1.4.21.4 Type
 - 2.1.4.21.5 Insulation class
 - 2.1.4.21.6 Temperature rise
 - 2.1.4.21.7 Connection diagram
 - 2.1.4.21.8 Serial number.
- 2.1.4.22 Transformer to comply with following energy efficiency requirements:
 - 2.1.4.22.1 A minimum efficiency per CSA-802.2-12.
 - 2.1.4.22.2 Energy efficiencies in compliance with NRCan 2019 requirements.
- 2.2 **ACCEPTABLE MANUFACTURERS**
 - 2.2.1 Transformers shall be of one manufacturer. Acceptable manufacturers are:
 - 2.2.1.1 Hammond Power Solutions
 - 2.2.1.2 Schneider Electric
 - 2.2.1.3 Delta
 - 2.2.1.4 Rex Power Magnetics
 - 2.2.1.5 STI
- 3 **EXECUTION**
 - 3.1 **MOUNTING**
 - 3.1.1 Verify test reports, serial number and tag identification prior to installation.

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- 3.1.2 The maximum size transformer that is permitted to be suspended is 75 KVA.
- 3.1.3 Floor mount all dry type transformers over 75 KVA.
- 3.1.4 Ensure adequate clearance around the transformers for ventilation.
- 3.1.5 Install the transformers in a level and upright position.
- 3.1.6 Remove shipping supports only after the transformers have been installed and just before placing them into service.
- 3.1.7 Loosen the isolation pad bolts until no compression is visible.
- 3.1.8 Provide vibration mounting pads for all transformers regardless of mounting method.
- 3.1.9 The vibration isolation for transformers shall not be short-circuited by the installation of any rigid connections, such as taught flexible conduit.
- 3.2 CONNECTIONS
- 3.2.1 Make the primary and secondary wiring connections as shown.
- 3.2.2 Energize the transformers as soon as practicable after installation.
- 3.2.3 Adjust transformer taps as required to achieve suitable secondary voltage at loads.
- 3.3 EQUIPMENT IDENTIFICATION
- 3.3.1 Provide equipment identification nameplate in accordance with Section 26 05 53 - Identification for Electrical Systems.
- 3.4 SHOP DRAWINGS
- 3.4.1 Shop drawing for this section will not be reviewed prior to the short circuit, coordination and arc flash hazard studies being submitted and reviewed by the Consultant.

END OF SECTION

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Project No.: 2024-0112
Section Name: **Service Entrance and Utility Requirements**
Section No.: **2624 02**
Date: August 30, 2024

1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results – Electrical
- 1.1.2 Section 26 12 16 – Dry-Type Medium Voltage Power Transformers
- 1.1.3 Section 26 13 23 – Medium Voltage Metal-enclosed Switchgear
- 1.1.4 Section 26 24 02 – Switchboards
- 1.1.5 Concrete encased duct banks and maintenance hole.
- 1.1.6 Conform to relevant sections of specification for this and other Divisions.

1.2 SERVICE CHARACTERISTICS

- 1.2.1 The Alectra Utility feeds the building underground at 27.6kV, 3-phase, 4-wire, grounded.

1.3 SERVICE ENTRANCE

- 1.3.1 Underground duct bank must be provided between the property line, medium voltage switchgears, medium voltage transformer, and the main switchboard by this Contractor.
- 1.3.2 The primary feeders will be provided by the Power Authority.
- 1.3.3 The Power Authority will provide the medium voltage transformer as indicated.
- 1.3.4 The medium voltage power transformer will be customer-owned and to be provided as part of this Contract.
- 1.3.5 The Division 26 Contractor shall provide the transformer pad and cable pit and coordinate the erection of the screening. Provide the duct bank and all cabling to the new transformer pad.

1.4 SUBMISSION

- 1.4.1 Submit to the required Power Authority all drawings and information they require including electrical, mechanical, structural and architectural drawings pertaining to the primary switchgear and site plan.

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1.4.2 Submit to the required Power Authority the primary medium-voltage switchgear shop drawings showing in detail all metering arrangements and connection points for service.

1.5 APPROVALS

1.5.1 Obtain approval from the Power Authority for installation prior to proceeding with the work.

1.5.2 Advise the Power Authority in ample time, of the progress of the work to ensure that the construction schedule is coordinated with them and all other trades.

1.5.3 Apply to the Power Authority construction department 48 hours prior to excavating the primary duct bank trenches and pouring concrete.

1.6 ALLOWANCES

1.6.1 Include in the tender and pay all costs assessed against the Owner in respect to the electrical service installation.

2 **PRODUCTS**

Not Applicable

3 **EXECUTION**

3.1 GENERAL

3.1.1 All work relating to the utility services and installation of utility feeders shall be coordinated with the Power Authority.

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Switchboards**
Section No.: **26 24 13**
Date: August 30, 2024

1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results – Electrical
- 1.1.2 Section 26 – Commissioning for Electrical Systems
- 1.1.3 Section 26 – Identifications for Electrical Systems
- 1.1.4 Section 26 – Air Circuit Breakers
- 1.1.5 Section 26 – Moulded Case Circuit Breakers
- 1.1.6 Section 26 – Grounding – Secondary
- 1.1.7 Section 26 – Power Systems Studies
- 1.1.8 Section 26 – Surge Protective Devices
- 1.1.9 Conform to relevant sections of specification for this and other Divisions.

1.2 DESCRIPTION OF WORK

- 1.2.1 Supply, install and connect all switchboards as described hereinafter and in accordance with the requirements of the Contract Documents.
- 1.2.2 For service entrance switchboards make the utility service connections all as described.
- 1.2.3 The main switchboards shall comprise of main breakers, indicating instruments and outgoing breakers to provide a complete service and distribution system for the whole project.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- 1.3.1 Submit shop drawings and product data in accordance with Division 1 and Section 26 05 01.
- 1.3.2 Indicate on shop drawings.
 - 1.3.2.1 Dimensioned cable entry and exit locations.
 - 1.3.2.2 Dimensioned position and size of bus.

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- 1.3.2.3 Overall length, height and depth.
- 1.3.2.4 Dimensioned layout of internal and front panel mounted components.
- 1.3.2.5 Include time-current characteristic curves for circuit breakers and fuses.
- 1.4 MAINTENANCE DATA
- 1.4.1 Provide maintenance data for service entrance board for incorporation into manual specified in Division 1 and Section 26 05 01.
- 1.5 SOURCE QUALITY CONTROL
- 1.5.1 Consultant to witness final factory tests.
- 1.5.2 Notify Consultant in writing 5 days in advance that service entrance board is ready for testing.
- 1.5.3 Submit two copies of certified test results.
- 2 **PRODUCTS**
- 2.1 SERVICE ENTRANCE BOARD
- 2.1.1 Rating: Refer to electrical distribution single line diagram.
- 2.1.2 Short circuit current withstand rating: 65 kA (rms symmetrical).
- 2.1.3 Cubicles: free standing, dead front, size as indicated.
- 2.1.4 Barrier metering section from adjoining sections.
- 2.1.5 Provision for installation of power supply authority metering in barrier section.
- 2.1.6 Owners metering.
- 2.1.7 Distribution section – Residential and Tenants.
- 2.1.8 Distribution section – Building Services.
- 2.1.9 Hinged access panels with captive knurled thumb screws.
- 2.1.10 Bus bars and main connections: 99.3% copper aluminum.

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- 2.1.11 Bus from load terminals of main breaker main lugs of distribution section.
- 2.1.12 Identify phases with colour coding.
- 2.2 MOULDED CASE CIRCUIT BREAKERS
- 2.2.1 Refer to Section 26 28 16.01 Moulded Circuit Breakers.
- 2.2.2 Blanked off spaces and provisions for future units, including but not limited to cradle, wiring and line side connections.
- 2.3 GROUNDING
- 2.3.1 Copper ground bus extending full width of cubicles and located at bottom.
- 2.3.2 Lugs at each end for size 4/0 grounding cable.
- 2.4 GROUND FAULT UNIT
- 2.4.1 Copper ground bus extending full width of cubicles and located at bottom.
- 2.4.2 Lugs at each end for size 4/0 grounding cable.
- 2.5 GROUND FAULT EQUIPMENT PROTECTION
- 2.5.1 Refer to Section 26 28 18 Ground Fault Equipment Protection.
- 2.6 POWER SUPPLY AUTHORITY METERING
- 2.6.1 Separate compartment and metal raceway for exclusive use of power supply authority metering.
- 2.6.2 Mounting accessories and wiring for metering supplied by power supply authority:
 - 2.6.2.1 600V:120V potential transformers.
 - 2.6.2.2 Current transformers: sized to suit service rating. Provide as per the requirements of the local utility.
 - 2.6.2.3 Watthour meter.
 - 2.6.2.4 Demand meter with kWh register.
- 2.7 FINISHES

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2.7.1 Apply finishes in accordance with Section 26 05 00 – Common Work Results - Electrical.

2.7.1.1 Finish shall be manufacturer's standard gray.

2.8 MANUFACTURER

2.8.1 For list of acceptable manufacturers, refer to Section 26 90 00 – List of Acceptable Manufacturers.

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Locate service entrance board.

3.1.2 Connect main secondary service to line terminals of main breaker.

3.1.3 Connect load terminals of distribution breaker's to feeders.

3.1.4 Check factory made connections for mechanical security and electrical continuity.

3.1.5 Run one grounding conductor 4/0 AWG bare copper in 1" conduit from ground bus to building ground.

3.1.6 Check trip unit settings against co-ordination study to ensure proper working and protection of components.

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Panelboards**
Section No.: **26 24 16**
Date: August 30, 2024

1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results - Electrical.
- 1.1.2 Section 26 05 03 – Nameplates.
- 1.1.3 Section 26 05 29 – Hangers & Supports.
- 1.1.4 Section 26 28 15.01 – Moulded Case Circuit Breakers.
- 1.1.5 Conform to relevant sections of specification for this and other Divisions.

1.2 SHOP DRAWINGS

- 1.2.1 Submit shop drawings in accordance with Section 26 05 00 – Common Work Results - Electrical.
- 1.2.2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

2 **PRODUCTS**

2.1 PANELBOARDS

- 2.1.1 Panelboards: product of one manufacturer.
 - 2.1.1.1 Install circuit breakers in panelboards before shipment.
- 2.1.2 For 208V receptacle and lighting panelboards, the bus, the main breaker and the branch breakers must be rated for a minimum of 14,000 A (symmetrical) interrupting capacity except as otherwise indicated.
- 2.1.3 For 208V distribution panelboards, the bus, the main breaker and the branch breakers must be rated to a minimum of 25,000 A (symmetrical) interrupting capacity except as otherwise indicated.
- 2.1.4 For 600 V panelboards, the bus, the main breaker and the branch breakers must be rated for a minimum of 35,000 A (symmetrical) interrupting capacity except as otherwise indicated
- 2.1.5 Provide a full size neutral.
- 2.1.6 Provide neutral with 200% the rating of mains, where indicated.

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- 2.1.7 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- 2.1.8 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- 2.1.9 Two keys for each panelboard and key panelboards alike.
- 2.1.10 Copper bus with neutral of same ampere rating as mains, unless indicated otherwise.
- 2.1.11 Mains: suitable for bolt-on breakers.
- 2.1.12 Trim with concealed front bolts and hinges.
- 2.1.13 Trim and door finish specified in Section 26 05 00 – Common Work Results - Electrical.
- 2.1.14 Enclosure shall be sprinkler-proof for indoor applications
- 2.1.15 Hot-dip galvanize the panelboard tubs after fabrication or acid etch, prime and apply two (2) finish coats.
- 2.1.16 Panelboards shall be finished with two coats of air dried ASA 61 or ASA 49 grey enamel to the panelboard tubs. Finish shall be over sprayed.
- 2.1.17 Provide doors with concealed hinges, locks and hardware for all panelboards
- 2.2 CUSTOM BUILT PANELBOARD ASSEMBLIES
 - 2.2.1 Provide custom fabricated replacement trims and doors for existing panels, as indicated on drawings.
 - 2.2.2 Replacement trim and door assembly shall be NEMA-4X type, and shall be coordinated with the architectural division to suit any modifications to the wall construction and/or finishes.
- 2.3 BREAKERS
 - 2.3.1 Breakers: to Section 26 28 21 - Moulded Case Circuit Breakers.
 - 2.3.2 Provide breakers as specified.
 - 2.3.3 Main breaker: separately mounted on top or bottom of panel to suit

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cable entry. When mounted vertically, down position should open breaker.

- 2.3.4 Lock-on devices for fire alarm, emergency, door supervisory, intercom, snow melting pipe tracing, stairway, exit and night light circuits.

2.4 EQUIPMENT IDENTIFICATION

- 2.4.1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results - Electrical.

- 2.4.2 Nameplate for each panelboard.

- 2.4.3 Complete circuit directory with typewritten legend showing location and load of each circuit.

2.5 MANUFACTURER

- 2.5.1 Panelboards shall be of one manufacturer. Acceptable manufacturers are as follows:

- 2.5.1.1 Schneider Electric

- 2.5.1.2 Eaton – Cutler Hammer

- 2.5.1.3 Siemens

3 **EXECUTION**

3.1 INSTALLATION

- 3.1.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

- 3.1.2 Install surface mounted panelboards on block walls or plywood backboards. Where practical, group panelboards on common backboard.

- 3.1.3 Mount panelboards to height specified in Section 26 05 00 – Common Work Results - Electrical or as indicated.

- 3.1.4 Field-measure all existing panels and fabricate customized components to suit. Any and/or all work may take place during evenings and/or weekends and shall suit the Owner's schedule. No additional charges shall be incurred by the Owner for work required to take place during shutdowns after-hours.

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3.1.5 Connect loads to circuits.

3.1.6 Connect neutral conductors to common neutral bus, with
respective neutral identified.

END OF SECTION

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Project No.: 2024-0112
Section Name: **Wiring Devices**
Section No.: **26 27 26**
Date: August 30, 2024

1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results – Electrical.
- 1.1.2 Conform to relevant sections of specification for this and other Divisions.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- 1.2.1 Submit shop drawings and product data in accordance with Section
- 1.2.2 26 05 00 – Common Work Results – Electrical.
- 1.2.3 Product data: Catalog cuts of specified devices upon request as well as field samples
- 1.2.4 Samples of specified devices upon request.

2 **PRODUCTS**

2.1 QUALITY ASSURANCE

- 2.1.1 Equipment and materials of type for which there are Underwriters Laboratories standard requirements, CSA Certified, listing and labels, shall be listed and labeled by Underwriters Laboratories.
- 2.1.2 Where equipment and materials have industry certification, labeling or standards (i.e., NEMA – National Electrical Manufacturers Association), this equipment shall be labeled as certified, or comply with standards.
- 2.1.3 Material and equipment shall be new and conform to grade, quality and standards specified. Equipment or materials of the same type shall be the product of same manufacturer throughout.
- 2.1.4 The Manufacturer's catalog numbers specified represented the minimum standards required.

2.2 WIRING DEVICES

- 2.2.1 General:
- 2.2.1.1 Commercial grade wiring devices shall be installed in all areas.

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2.2.2 GFCI Receptacle:

2.2.2.1 GFCI receptacles shall be cUL Listed and CSA Certified. Meet cUL943 performance requirements.

2.2.2.2 GFCI receptacles shall have recessed test and reset buttons to avoid accidental tripping from oversized molded plugs.

2.2.2.3 Contacts shall be reinforced to assure maximum plug retention.

2.2.2.4 Large, combination back and side wire terminals to accept up to #10 Wires.

2.2.2.5 GFCI receptacles shall have LED Indicator Light which will flash red to indicate when device no longer has GFCI protection.

2.2.2.6 Receptacles shall be Hubbell 15A (GF15LA), 20A (GF20LA)

2.2.3 Receptacles Decorative Series Spec Grade:

2.2.3.1 Receptacles shall represent high quality performance.

2.2.3.2 Receptacles shall be rated for 15 or 20 amperes as indicated on drawings.

2.2.3.3 Receptacles shall be back and side wired. Decorator style, provide green base ground screw terminal, automatic ground clip, fully enclosed in a nylon face, and have wrap around steel bridge for installation strength, and high heat base.

2.2.3.4 In general, all receptacles shall be of ampere, voltage and type as indicated on drawings or herein specified. The following listings and catalog numbers are for type and quality guideline:

2.2.3.4.1 Receptacle shall be Hubbell 15A HBL2152, 20A HBL2162 series.

2.2.4 Switches Decorative Spec Grade:

2.2.4.1 Switches shall be 15A or 20A rated and must have "framed" outline body to fit stylized plate.

2.2.4.2 Switches shall have heat resistant thermo set base and 100% copper contact arm and nylon face.

2.2.4.3 15A Hubbell Type Single Pole HBL2101, 3 WAY HBL2103, 4 WAY HBL2104.

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- 2.2.4.4 20A Hubbell Type Single Pole HBL2121, 3 WAY HBL2123, 4 WAY HBL2124.
- 2.2.5 Isolated Ground Receptacles:
 - 2.2.5.1 Straight blade isolated ground receptacles, 15 or 20 amp 125 volt service shall have isolation method as an integral part of the device. Shall have nylon insulating barrier between grounding contacts and receptacle mounting strap.
 - 2.2.5.2 All isolated ground receptacles (straight blade and twist lock) shall have impact resistant thermoplastic face and dimensionally stable base.
 - 2.2.5.3 All isolated ground receptacles are required to have an orange triangle located on the face of the device. If the receptacle face is orange, a black triangle outline is required.
 - 2.2.5.4 Provide isolated ground receptacles rated 15 amp 125 volt NEMA 5-15R configuration and manufactured by Hubbell, Inc., type IG2152.
- 2.2.6 Surge Suppression Receptacles:
 - 2.2.6.1 Shall have 4 series parallel 150V (MOVs) and provide 210 joules of transient voltage suppression in all modes, i.e., Normal & Common.
 - 2.2.6.2 Shall have visual and audible surge status indicators to alert user to surge suppression circuit condition. Visual indicator will be illuminated (red) when power is on and surge suppression circuit is fully functional. Visual indicator will not be illuminated when power is off. Visual indicator will be flashing when surge suppression circuit has been damaged. Audible indicator will be silent when surge suppression circuit is fully functional. Audible indicator will sound a constant alarm if surge suppression circuit has been damaged and can be silenced with muting screw feature on device face. (Audible alarm feature not available on all models.)
 - 2.2.6.3 A line voltage rated fuse, specially calibrated to disconnect the surge suppression circuit in the event of catastrophic failure shall be used.
 - 2.2.6.4 Provide receptacles which shall be rated 15 ampere 125 Volt with NEMA 5-15R configuration and manufactured by Hubbell Inc., type HBL5262S or approved equal.

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2.2.7 Twist – Lock Receptacles:

2.2.7.1 The approved manufacturer is Hubbell, Inc. or approved equal if they meet the design parameters set forth:

2.2.7.1.1 NEMA Twist – Lock Receptacles.

2.2.7.1.2 Face (top) shall be nylon with boss diameter of 1.56” on both 20 and 30 amp receptacles.

2.2.7.1.3 Face shall also have identifying colour coding feature (colour coding in accordance to IEC 309 standard) by voltage rating to assure proper mating of devices.

2.2.7.1.4 Terminal screws shall be #10 silicone bronze and accommodate back or side wiring. 20 amp receptacle terminal shall be capable of accepting #8 AWG wire and provide wire restraint non-loosening design.

2.2.7.1.5 Base shall be constructed of dimensionally stable, heat resistant material.

2.2.7.1.6 Contact arm shall be one – piece (no riveted assembly) and shall also provide oxide cutting feature for termination integrity.

Twist – Lock 30 Ampere Devices					
CATALOG NUMBERS					
Rating Body	Voltage	NEMA	Rec.	Male Plug	Conn.
2 Pole 3 wire	125 250	L5-30 L6-30	HBL2610 HBL2620	HBL2611 HBL2621	HBL2613 HBL2623
3 Pole 3 wire	125/250V AC 3Ø250V AC 3Ø480V AC 3Ø600V	L14-30 L15-30 L16-30 L17-30	HBL2710 HBL2720 HBL2730 HBL2740	HBL2711 HBL2721 HBL2731 HBL2741	HBL2713 HBL2723 HBL2733 HBL2743
3 Pole 4 wire	3ØY120 / 208V AV	L21-30	HBL2810	HBL2811	HBL2813
Twist – Lock 20 Ampere Devices					
CATALOG NUMBERS					
Rating Body	Voltage	NEMA	Rec.	Male Plug	Conn.

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2 Pole 3 wire	125 250 277V AC	L5-20 L8-20 L7-20	HBL2310 HBL2320 HBL2330	HBL2311 HBL2321 HBL2331	HBL2313 HBL2323 HBL2333
3 Pole 4 wire	125/250V AC 3Ø250V AC 3Ø480V AC	L14-20 L15-20 L16-20	HBL2410 HBL2420 HBL2430	HBL2411 HBL2421 HBL2431	HBL2413 HBL2423 HBL2433
4 Pole 5 wire	3ØY120	L21-20	HBL2510	HBL2511	HBL2513

2.2.8 USB Charging Convenience Receptacles:

2.2.8.1 Receptacles shall be compatible with USB 1.1/2.0/3.0 devices, including Apple Products.

2.2.8.2 Receptacles shall be rated for 15 or 20 amperes as indicated on drawings.

2.2.8.3 Receptacles shall be back and side wired.

2.2.8.4 Duplex Receptacles shall be complete with 2 USB charging ports.

2.2.8.5 In general, all receptacles shall be of ampere, voltage and type as indicated on drawings or herein specified. The following listings and catalog numbers are for type and quality guideline:

2.2.8.5.1 Receptacle shall be Hubbell USB15X series.

2.2.9 Wall Plates:

2.2.9.1 Device plates, dimmer switches plates, telecommunication outlet plates, and blank plates for junction boxes, etc. shall be as follow:

2.2.9.1.1 Vertically brushed stainless steel, cover plates 0.04" (1 mm) thick for wiring devices mounted in flush-mounted outlet boxes.

2.2.9.1.2 Galvanized sheet steel utility box covers for wiring devices installed in surface-mounted utility boxes.

2.2.9.1.3 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

2.2.9.1.4 Ceiling mounted devices cover plates shall match device colour.

2.3 FINISHES

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2.3.1 Wiring Devices:

2.3.1.1 General: Devices shall have manufacturer's standard white finish.

2.3.1.2 Service Rooms: Devices shall have manufacturer's standard black finish.

2.3.2 Cover Plate:

2.3.2.1 In Residential Suites: Provide Plastic/nylon cover plate of the same finish as the wiring devices.

2.3.2.2 In Offices: Provide Plastic/nylon cover plate of the same finish as the wiring devices.

2.3.2.3 In Corridor and Lobby: Provide Brushed Aluminum cover plates.

2.3.2.4 In Parking Garage and Services Rooms: Provide Stainless Steel cover plates.

2.4 MANUFACTURERS

2.4.1 Provide wiring devices and cover plates of one (1) manufacturer.

2.4.2 Hubbell Canada LP. Catalogue numbers are shown and indicate the quality of the wiring devices and cover plates required. Equivalent wiring devices and cover plates of other manufacturers may be used.

2.4.3 Acceptable manufacturers are as follows:

2.4.3.1 Hubbell Canada

2.4.3.2 Pass & Seymour

2.4.3.3 Leviton (Specification Grade only)

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Switches:

3.1.1.1 Install single throw switches with handle in "UP" position when switch closed.

3.1.1.2 Install switches in gang type outlet box when more than one switch is required in one location.

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- 3.1.1.3 Mount toggle switches at height specified in Section 26 05 00, Common Work Results – Electrical, or as indicated.
- 3.1.2 Receptacles:
 - 3.1.2.1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - 3.1.2.2 Mount receptacles at height specified in Section 26 05 00 – Common Work Results - Electrical or as indicated.
 - 3.1.2.3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- 3.1.3 Cover plates:
 - 3.1.3.1 Protect cover plate finish with paper or plastic film until painting and other work is finished.
 - 3.1.3.2 Install suitable common cover plates where wiring devices and/or dimmer switches are grouped.
 - 3.1.3.3 Do not use cover plates meant for flush outlet boxes on surface – mounted boxes.

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Fuses - Low Voltage**
Section No.: **26 28 13**
Date: August 30, 2024

1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results - Electrical.
- 1.1.2 Section 26 28 23 – Disconnect Switches Fused & Non-Fused.
- 1.1.3 Conform to relevant sections of specification of this and other Divisions.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- 1.2.1 Submit shop drawings and product data in accordance with Section 26 05 00 – Common Work Results – Electrical.
- 1.2.2 Submit fuse performance data characteristics for each fuse type and size above 60A. Performance data to include: average melting time-current characteristics, (for fuse coordination), and peak let-through current.

1.3 MAINTENANCE MANUALS

- 1.3.1 Three spare fuses of each type and size installed above 600 A.
- 1.3.2 Six spare fuses of each type and size installed up to and including 600 A.

1.4 DELIVERY AND STORAGE

- 1.4.1 Ship fuses in original containers.
- 1.4.2 Store fuses in original containers in storage cabinet and moisture free location.

2 **PRODUCTS**

2.1 FUSES GENERAL

- 2.1.1 Fuse type references L1, L2, J1, R1 etc. have been adopted for use in this specification.
- 2.1.2 Fuses: product of one manufacturer.

2.2 FUSE TYPES

- 2.2.1 HRC-L fuses (formerly Class L).

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- 2.2.1.1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
- 2.2.1.2 Type L2, fast acting.
- 2.2.2 HRCI-J fuses (formerly Class J).
- 2.2.2.1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
- 2.2.2.2 Type J2, fast acting.
- 2.2.3 HRCI-R fuses (formerly Class R). For UL Class RK1 fuses, peak let-through current and values not to exceed limits of UL 198E-1982, table 10.2.
- 2.2.3.1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.
- 2.2.3.2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.
- 2.2.3.3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.
- 2.2.3.4 HRCII-C fuses (formerly Class C).
- 3 **EXECUTION**
- 3.1 INSTALLATION
- 3.1.1 Install fuses in mounting devices immediately before energizing circuit.
- 3.1.2 Ensure correct fuses fitted to physically match mounting devices.
- 3.1.2.1 Install Class R rejection clips for HRCI-R fuses.
- 3.1.3 Ensure correct fuses fitted to assigned electrical circuit.
- 3.1.4 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.
- 3.1.5 Fuses protecting motor loads and transformers to be type J1 for up to and including 600 A and L1 for ratings above 600 A.

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- 3.1.6 Fuses protecting feeder circuits to be type J2 for up to and including 600 A, and type L2 for ratings above 600 A.
- 3.1.7 Fuses protecting other services or equipment shall be of the type required for that purpose.

END OF SECTION

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1 GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results - Electrical.
- 1.1.2 Section 26 05 53 – Identification for Electrical Systems.
- 1.1.3 Section 26 24 13 - Switchboards
- 1.1.4 Section 26 24 16 – Panelboard.
- 1.1.5 Conform to relevant sections of specification for this and other Divisions.

1.2 STANDARDS

- 1.2.1 CAN/CSA-C22.2 No. 144-M91 (R2001): Ground Fault Circuit Interrupters.
- 1.2.2 CSA C22.2 No. 5-02: Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
- 1.2.3 CSA C22.1-02-Canadian Electrical Code.
- 1.2.4 UL 489 (2002) Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.
- 1.2.5 ANSI C37.17 (latest) American National Standard for trip devices for AC and general purpose DC low voltage power circuit breakers.
- 1.2.6 NEMA-AB1-1993 Molded case circuit breakers and molded case switches.
- 1.2.7 ANSI C37.50 American National Standard for Switchgear – test procedures for low voltage AC power circuit breakers used in enclosures.
- 1.2.8 IEEE Standard 1015, specifically acceptance practice.
- 1.2.9 NETA –ATS Section 7.
- 1.2.10 Ontario Electrical Safety Code.
- 1.2.11 Section 26 05 10 – Short Circuit, System Coordination & Arc Flash Study.

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1.3 PRODUCT DOCUMENTATION

- 1.3.1 Submit shop drawings in accordance with Section 26 05 01. There will be details such as dimensions, clearances required, cable entries, tabulation of all devices including tags, wiring diagrams (power ,signals, control wiring). The notes will identify field wiring and factory installed wiring).
- 1.3.2 Include time-current characteristic curves for breakers with ampacity of 150A and over. In some cases due to critical nature of the equipment smaller size breaker may have to be verified for Time Current coordination as well.

2 **PRODUCTS**

2.1 BREAKERS GENERAL

- 2.1.1 Provide bolt-on molded case circuit breaker, quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient as indicated.
- 2.1.2 Circuit breakers that are 400 amps and higher that are part of the emergency distribution system shall be 100% rated.
- 2.1.3 Provide multi-pole breakers with a common-trip device and a single handle.
- 2.1.4 Provide 100% rated breaker where indicated.
- 2.1.5 All breakers 400 amps and higher shall be LSI solid state trip type.
- 2.1.6 Provide magnetic instantaneous trip elements in circuit breakers, to operate only when the value of the current reaches the setting, as indicated. For breakers with adjustable trips, provide a trip range of 3 to 10 times the rated current or as indicated.
- 2.1.7 Provide circuit breakers with interchangeable trips as indicated.
- 2.1.8 Provide pad locking devices on all breakers to lock the handle of a breaker in the "on" or "off" position with the trip units to remain free to function and protect the circuit from both overload and short circuit conditions.

2.2 THERMAL MAGNETIC BREAKERS (TMB)

- 2.2.1 Provide molded case circuit breakers to operate automatically by means of thermal and magnetic tripping devices to provide inverse

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time current tripping characteristic.

2.3 FUSED THERMAL MAGNETIC BREAKERS (FTMB)

2.3.1 Provide fused thermal magnetic breakers with current limiting fuses internally mounted. Coordinate the time vs current characteristics and the time current limiting characteristics of the fuses with the time vs current tripping characteristics of the circuit breakers resulting in the circuit interruption by the breaker of currents up to the interrupting capacity of the breaker and the circuit interruption by the fuses above the interrupting capacity of the breaker. Provide individually removable fuses interlocked with the breaker such that the removal of the fuse cover, the blowing of a fuse or the removal of a fuse will trip the breaker.

2.4 MAGNETIC BREAKERS

2.4.1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

2.5 SOLID STATE TRIP BREAKERS

2.5.1 Provide moulded case circuit breakers to operate by means of a solid-state trip unit with associated current monitors and self-powered shunt trip devices to provide an inverse time vs current trip characteristic under overload conditions, and long-time short time instantaneous tripping for phase ground fault short circuit protection.

2.6 OPTIONAL FEATURES

2.6.1 Provide NEMA and UL rated enclosures for individual breakers as required.

2.7 MANUFACTURER

2.7.1 Provide breakers of one manufacturer. Breakers shall be of same manufacturer as the panelboards:

2.7.2 Acceptable manufacturers are as follows:

2.7.2.1 Schneider Electric

2.7.2.2 Eaton – Cutler-Hammer

2.7.2.3 Siemens

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3 EXECUTION

3.1 EXAMINATION

- 3.1.1 Examine the circuit breakers for compliance with installation tolerances and other conditions affecting performance. Proceed with installation only after satisfactory compliance.

3.2 INSTALLATION

- 3.2.1 Circuit breakers in panelboards shall be factory installed.
- 3.2.2 Install other individual breakers where indicated.

3.3 IDENTIFICATION

- 3.3.1 Identify all field installed conductors, wiring and components; provide warning signs as required by manufacturer and also CEC and Ontario Electrical Safety Code. Install engraved nameplates and lamacoid nameplates on enclosures.

3.4 CONNECTION

- 3.4.1 Install grounding connections, power wiring and indication devices. Verify the torque recommended by manufacturer.

3.5 TESTS

- 3.5.1 Test for continuity of phase and ground connections and insulation resistance (Megger) for each phase to phase and phase to ground.
- 3.5.2 Verify all acceptance tests as per NETA test procedure.
- 3.5.3 Any malfunctioning of the units shall be corrected and retested to demonstrate compliance.

3.6 SUBMITTALS

- 3.6.1 Field test reports: Include the test procedures and instruments used. Record test results for formal submission to consultant and owner for information.
- 3.6.2 Final maintenance manual shall include all the routine maintenance requirements and complete information about each circuit breaker settings.

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END OF SECTION

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Section Name: **Ground Fault Equipment Protection**
Section No.: **26 28 18**
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1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 –Common Work Results - Electrical.
- 1.1.2 Conform to relevant sections of specification for this and other Divisions.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- 1.2.1 Submit shop drawings and product data in accordance with Section 26 05 00.
- 1.2.2 Ground fault protective equipment: product of one manufacturer.

2 **PRODUCTS**

2.1 EQUIPMENT

- 2.1.1 Provide ground fault protection on 2000A, 347/600 V, 4 wire, 3 phase service.
- 2.1.2 Ground fault unit to contain:
 - 2.1.2.1 Ground sensing relay suitable for operation at 30 mA 2000 A factory set.
 - 2.1.2.2 Three position sensitivity control switch to select value of leakage current at which relay will operate.
 - 2.1.2.3 Switch:
 - 2.1.2.3.1 SPDT contacts for alarm and trip.
 - 2.1.2.3.2 Mechanical target indication.
 - 2.1.2.3.3 Manually reset.
 - 2.1.2.4 Reset button for contacts and target.
 - 2.1.2.5 Suitable for panel mounting.
- 2.1.3 Zero sequence transformer rectangular type with 300 - 3000 mA range.

2.2 FABRICATION

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2.2.1 Install following components in equipment specified in other Sections and as indicated.

2.2.1.1 Zero sequence transformer.

2.2.1.2 Ground fault relay.

2.2.1.3 Ground resistor unit.

2.3 RELATED EQUIPMENT

2.3.1 Section 26 28 21 - Moulded Case Circuit Breakers

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Do not ground neutral on load side of sensor.

3.1.2 Install phase conductors including neutral through zero sequence transformer.

3.1.3 Install ground fault protection system.

3.1.4 Make connections as indicated and in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

3.2.1 Perform tests in accordance with Section 26 05 00 – Common Work Results - Electrical.

3.2.2 Arrange and pay for field testing of ground fault equipment by ground fault equipment manufacturer before commissioning service.

3.2.3 Submit report of tests to Consultant and certificate that system as installed meets criteria specified.

3.2.4 Demonstrate simulated ground fault tests.

END OF SECTION

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1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results - Electrical.
- 1.1.2 Section 26 05 53 – Identification for Electrical Systems.
- 1.1.3 Conform to relevant sections of specification for this and other Divisions.

1.2 PRODUCT DATA

- 1.2.1 Submit product data in accordance with Section 26 05 00 – Common Work Results - Electrical.
- 1.2.2 Standards: Design, manufacture and test all disconnect switches in accordance with good industry practice and in accordance with the following Standards and Codes:
- 1.2.3 CSA Standard C22.2 No. 4 Enclosed switches;
- 1.2.4 CSA Standard C22.2 No. 39 Fuseholder assemblies.

2 **PRODUCTS**

2.1 DISCONNECT SWITCHES

- 2.1.1 Provide fusible and non-fusible disconnect switches in CSA Enclosure to suit the environment where the switch is located.
- 2.1.2 Provide the provision for padlocking the switch in the ON and OFF switch position by using one lock via a multi-lock hasp.
- 2.1.3 Mechanically interlocked door to prevent opening when handle in ON position.
- 2.1.4 Fuses: size as indicated, to Section 26 28 14 - Fuses - Low Voltage.
- 2.1.5 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
- 2.1.6 Provide a type A quick-make, quick-break switching action with arc chutes or arc snuffers.
- 2.1.7 Provide a vertically moving handle with an ON-OFF switch position

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indication on the switch enclosure cover with the ON position being the upper handle position.

- 2.1.8 Provide solderless neutral terminals where indicated.
- 2.1.9 Disconnect switches integrated rating must be rated to handle the design interrupting capacity for this project.
- 2.1.10 Ensure system coordination per Section 26 05 10 prior to ordering of the equipment.

2.2 EQUIPMENT IDENTIFICATION

- 2.2.1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results - Electrical.
- 2.2.2 Indicate name of load controlled on nameplate.
- 2.2.3 If part of the emergency distribution system, it shall be finished in Sherwin Williams #F65E37.

2.3 ACCEPTABLE MANUFACTURERS

- 2.3.1 Provide all disconnect switches of one manufacturer. Acceptable manufacturers are as follows:
 - 2.3.1.1 Schneider Electric
 - 2.3.1.2 Eaton – Cutler-Hammer
 - 2.3.1.3 Siemens

2.4 ENCLOSURE

- 2.4.1 Individually mounted disconnect switch shall be installed in Sprinkler proof enclosure c/w drip shield.

3 **EXECUTION**

3.1 INSTALLATION

- 3.1.1 Install disconnect switches complete with fuses if applicable.

END OF SECTION

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1 **GENERAL**

1.1 RELATED SECTIONS

- 1.1.1 Section 26 05 00 – Common Work Results Electrical
- 1.1.2 Section 26 36 13 – Power Generation Natural Gas
- 1.1.3 Conform to relevant sections of specification for this and other Divisions.

1.2 REFERENCES, CODES, AND STANDARDS

- 1.2.1 UL 1008 – Standard for Transfer Switch Equipment
- 1.2.2 CSA C22.2 No. 178 – Automatic Transfer Switches
- 1.2.3 CSA-C282-09 – Emergency Electrical Power Supply for Buildings
- 1.2.4 CSA-C22.1-12 – Ontario Electrical Safety Code
- 1.2.5 IEC 947-6-1 – Low-voltage Switchgear and Controlgear; Multifunction Equipment; Automatic Transfer Switching Equipment
- 1.2.6 IEEE Standard 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
- 1.2.7 NEMA Standard 446 – ICS10-1993 – AC Automatic Transfer Switches

1.3 SYSTEM DESCRIPTION

- 1.3.1 Furnish and install automatic transfer switches (ATS) with number of poles, amperage, voltage, withstand, and close-on ratings as shown on the plans. Each system shall include the transfer mechanism as described within this specification section and be complete with a integral microprocessor controller to facilitate the automatic operation. All switches and controllers shall be the products of the same manufacturer.

1.4 MANUFACTURERS

- 1.4.1 Subject to compliance with specified requirements of this section.
- 1.4.2 ATS shall be by one of the following acceptable manufacturer's

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product:

1.4.2.1 ASCO 4000 Series

1.4.2.2 Eaton

1.5 SHOP DRAWINGS

1.5.1 Submit shop drawings in accordance with Section 26 05 00 – Common Work Results – Electrical and 26 05 53 – Identification for Electrical Systems.

1.5.2 Submittal shall include all pertinent details of the system including, but not limited to, the following:

1.5.2.1 Make, model, and type

1.5.2.2 Front view and plan view of the assembly

1.5.2.3 Dimensions and weight

1.5.2.4 Clearances required

1.5.2.5 Schematic diagram

1.5.2.6 Conduit space locations within the assembly

1.5.2.7 Assembly ratings including

1.5.2.7.1 Withstand and Closing rating

1.5.2.7.2 Voltage

1.5.2.7.3 Continuous current rating

1.5.2.7.4 Short-Time rating if applicable

1.5.2.7.5 Short-circuit rating if ordered with integral protection

1.5.2.8 Cable Terminal sizes

1.5.2.9 Product Data Sheets

1.5.2.10 Interface connections wiring, including status and indications;

1.5.2.11 Communication wiring;

1.5.2.12 Summary of relays, I/O contacts, and terminals (including spares);

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- 1.5.2.13 Settings in order to implement full intent of the automatic transfer switch.;
- 1.5.2.14 The system coordination (protection) requirement shall be clearly indicated for the work related to this section. This information shall also be provided to the professional providing services for Short Circuit, System Coordination Study. The upstream breaker clearing time shall be noted on the drawings;
- 1.5.3 A certificate indicating that the unit being supplied is similar to the type tested at the factory and meets all the tests indicated in the standards.
- 1.5.4 Heat dissipation during normal source operation and emergency source operation at full load shall be provided within +/- 10% accuracy.
- 1.6 CLOSEOUT SUBMITTALS
- 1.6.1 Provide operation and maintenance data for automatic load transfer equipment for incorporation into manual specified 16010 – Electrical General Requirements. The following information shall be included for record purposes:
 - 1.6.1.1 Final as-built drawings and information for items listed in Section 1.4
 - 1.6.1.2 Wiring diagrams
 - 1.6.1.3 Certified production test reports
 - 1.6.1.4 Installation information
 - 1.6.1.5 Seismic certification as specified
 - 1.6.1.6 Detailed instructions to permit effective operation, maintenance and repair
- 1.7 QUALIFICATIONS
- 1.7.1 The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- 1.7.2 For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- 1.7.3 The manufacturer of this equipment shall have produced similar

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electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

2 PRODUCTS

2.1 MECHANICAL HELD TRANSFER SWITCH

- 2.1.1 The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, solenoid mechanism. Main operators which include overcurrent disconnect devices, linear motors or gears shall not be acceptable.
- 2.1.2 All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.
- 2.1.3 Each transfer switch shall be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources under either automatic or manual operation. Main contacts shall be mechanically held in position in both normal and emergency positions.
- 2.1.4 Transfer switches shall be open transition and provided with an in-phase monitor feature, which will permit a transfer or retransfer between two live sources that have a phase angle difference of +/- 8 degrees or less. In the event that the switch cannot transfer in-phase, the switch will default to a time delay in neutral transfer adjustable 0-120 seconds.
- 2.1.5 The automatic transfer switch shall be of double throw construction operated by a reliable electrical mechanism momentarily energized. There shall be a direct mechanical coupling to facilitate transfer in 6 cycles or less.
- 2.1.6 All main contact shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.
- 2.1.7 Inspection of all components of molded –cases circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources, are not acceptable.
- 2.1.8 On transfer switches requiring a fourth pole for switching the

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neutral, the neutral shall be identical to the other power poles. Switches neutral poles which are add-on or overlap, or that are not capable of breaking fully rated load current are not acceptable.

- 2.1.9 Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.

2.2 MICROPROCESSOR CONTROLLER

- 2.2.1 The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.
- 2.2.2 A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to +/- 1% of nominal voltage. Frequency sensing shall be accurate to +/-0.2%. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.
- 2.2.3 The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage for the operator's manuals.

2.3 ENCLOSURE

- 2.3.1 The transfer switch shall be furnished in a NEMA Type 1 enclosure, unless otherwise shown on the plans, suitable for use in environments indicated in the drawings.
- 2.3.2 Provide sprinkler hood.
- 2.3.3 Finish shall be ANSI 61 grey or manufacturer's standard grey.
- 2.3.4 Provide a complete mimic bus label. Mimic bus shall have white lines and lettering on red background. The mimic bus shall be

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coordinated with the other pieces of distribution equipment that are related.

2.4 EQUIPMENT IDENTIFICATION

2.4.1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results – Electrical and 26 05 53 - Identification for Electrical Systems.

3 **OPERATION**

3.1 CONTROLLER DISPLAY AND KEYPAD

3.1.1 A LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. All parameter set points shall be password protected and programmable using the controller keypad or be adjustable via DIP switches on the controller:

3.1.1.1 Nominal line voltage and frequency

3.1.1.2 Single or three phase sensing

3.1.1.3 Operating parameter protection

3.1.1.4 Transfer operating mode configuration

3.1.2 The microprocessor-based controller shall include a minimum display consisting of four (4) individual LED's for indicating the following:

3.1.2.1 Availability status of NORMAL source

3.1.2.2 Availability status of EMERGENCY source

3.1.2.3 Connection status of NORMAL source

3.1.2.4 Connection status of EMERGENCY source

3.2 VOLTAGE AND FREQUENCY SENSING

3.2.1 Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified):

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Parameter	Sources	Dropout/Trip	Pickup/Reset
Undervoltage	N & E, 3-ph	70 to 98%	85 to 100%
Overvoltage	N & E, 3-ph	102 to 115%	2% below trip
Underfrequency	N & E	85 to 98%	90 to 100%
Overfrequency	N & E	102 to 110%	2% below trip
Voltage Unbalance	N & E	5 to 20%	1% below dropout

- 3.2.2 Repetitive accuracy of all settings shall be within +/- 5% over an operating temperature range of -20 to +60 degrees C.
- 3.2.3 Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.
- 3.2.4 The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).
- 3.2.5 The controller shall include a user selectable algorithm to prevent repeated transfer cycling to a source on an installation which experiences primary side, single phase failures on a Ground Why – Ground Wye transformer which regenerated voltage when unloaded. The algorithm shall also inhibit retransfer to the normal (utility) sources upon detection of a single phasing condition until a dedicated timer expires, the alternate source fails, or the normal source fails completely and is restored during this time delay period. The time delays associated with this feature shall be adjustable by the user through the controller keypad and LCD.
- 3.3 TIME DELAYS
- 3.3.1 A time delay shall be provided on transfer to EMERGENCY source, adjustable from 0 to 1800 seconds.
- 3.3.2 A time delay shall be provided to override a momentary power outage or voltage fluctuation, adjustable from 0 to 120 seconds.
- 3.3.3 A time delay shall be provided on retransfer from EMERGENCY to

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NORMAL source, adjustable from 0 to 1800 seconds.

- 3.3.4 A time delay shall be provided for engine failure to start, fixed setting of 6 seconds.
- 3.3.5 A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:
 - 3.3.5.1 Prior to transfer only
 - 3.3.5.2 Prior to and after transfer
 - 3.3.5.3 Normal to emergency only
 - 3.3.5.4 Emergency to normal only
 - 3.3.5.5 Normal to emergency and emergency to normal
 - 3.3.5.6 All transfer conditions or only when both sources are available.
- 3.3.6 All delays shall be field adjustable from the microprocessor-based controller without the use of special tools.
- 3.4 ADDITIONAL FEATURES
 - 3.4.1 A three position momentary-type test switch shall be provided for the test / automatic / reset modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.
 - 3.4.2 A SPDT contact, rated 5 amps at 30 VDC, shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.
 - 3.4.3 Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.
 - 3.4.4 LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to

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the emergency source (red).

- 3.4.5 LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.
- 3.4.6 Provide the ability to select “commit/no commit to transfer” to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.
- 3.4.7 An Inphase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The Inphase monitor shall be specifically designed for and be the product of the ATS manufacturer.
- 3.4.8 The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.
- 3.4.9 Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.
- 3.4.10 **Self-Diagnostics** - The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.
- 3.4.11 **Data Logging** – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:
 - 3.4.11.1 Engine Run Time
 - 3.4.11.2 NORMAL source Available time
 - 3.4.11.3 EMERGENCY source Available time

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- 3.4.11.4 NORMAL source Connected time
- 3.4.11.5 EMERGENCY source Connected time
- 3.4.11.6 LOAD Energized Time
- 3.4.11.7 Number of Transfers
- 3.4.11.8 Date, Time and Reason for Last Sixteen (16) transfers
- 3.4.11.9 Monitor Mode Event
- 3.4.11.10 Fail Safe Event
- 3.4.11.11 Aborted Test
- 3.4.12 **Communications Module** – For remote interfacing of furnished transfer switch. Shall allow the vendor's monitoring products to monitor and control the transfer switch equipment with the utilization of 128 – Bit AES encryption standard. An embedded webpage shall be provided for switch status, metered values and list up to 99 events in the log. Modbus and Simple Network Management Protocol (SNMP) shall be supported for open monitoring. Hardware shall include:
 - 3.4.12.1 10/100Mbps Ethernet port with connector for RJ45
 - 3.4.12.2 RS-485 port (2 wire or 4 wire)
 - 3.4.12.3 24 VDC input for optional remote power
 - 3.4.12.4 DIN rail mountable
 - 3.4.12.5 Onboard status LED's shall be provided for the following:
 - 3.4.12.5.1 Receiving operational power
 - 3.4.12.5.2 Transmitting and receiving data
 - 3.4.12.5.3 Ethernet and network status
 - 3.4.12.5.4 Diagnostic analysis
- 3.4.13 **External DC Power Supply** – An optional provision shall be available to connect an external 24 VDC power supply to allow the LCD and the door mounted control indicators to remain functional when both power sources are dead.

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3.5 WITHSTAND AND CLOSTING RATINGS

- 3.5.1 The transfer switch shall be rated to close on and withstand the available RMS symmetrical short circuit current at the transfer switch terminals with the type of overcurrent protection shown on the plans.
- 3.5.2 The transfer switch shall be UL listed in accordance with UL 1008 and be labelled in accordance with that standard's 0.025 and 0.05 second, time based ratings. The transfer switches which are not tested and labelled with the time based ratings and have series, or specific breaker ratings only, are not acceptable.

3.6 TESTS AND CERTIFICATION

- 3.6.1 The complete transfer switch shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
- 3.6.2 Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
- 3.6.3 The transfer switch manufacturer shall be certified to ISO 9001:2008 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001:2008.

4 **EXECUTION**

4.1 FIELD QUALITY CONTROL

- 4.1.1 Manufacturer to allow for test and commissioning of the automatic transfer switch following the installation of the equipment. Manufacturer shall coordinate tests and commissioning of the equipment with the electrical contractor responsible for the installation of the equipment.
- 4.1.2 Energize transfer equipment from normal power supply.

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- 4.1.3 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.
- 4.1.4 Set selector switch in "Manual" position and check to ensure proper performance.
- 4.1.5 Set selector switch in "Engine start" position and check to ensure proper performance. Return switch to "Auto" to stop engine.
- 4.1.6 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 min, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.
- 4.1.7 Repeat, at 1 h intervals and complete test with selector switch in each position, for each test.
- 4.2 SIGNALS TO OTHER SYSTEMS
- 4.2.1 Provide wire in conduit for pre-transfer and transfer signals to the elevator controller.
- 4.2.2 Provide wire in conduit for the status signal to the fire alarm system.
- 4.2.3 Provide wire in conduit for the signal to the standby generator.
- 4.3 TRAINING
- 4.3.1 Following complete installation of the transfer switch and the associated systems, a formal training session shall be conducted to demonstrate all functions and software information. Safety features shall be highlighted. Formal record of training shall be provided to the Owner along with the completed manual. Allow minimum 2 hours for the training.

END OF SECTION

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1 **GENERAL**

1.1 SCOPE

1.1.1 This section describes the materials and installation requirements for surge protective devices (SPD) for the protection of all AC electrical circuits.

1.2 RELATED SECTIONS

1.2.1 Section 26 05 00 Common Work Results - Electrical.

1.2.2 Conform to relevant sections of specification for this and other Divisions.

1.3 STANDARDS

1.3.1 The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:

1.3.1.1 Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, C62.45).

1.3.1.2 American National Standards Institute.

1.3.1.3 Federal Information Processing Standards Publication 94 (FIPS PUB 94).

1.3.1.4 National Electrical Manufacturer Association (NEMA LS-1 1992 All Tests).

1.3.1.5 MIL Standard 220A Method of Insertion Loss Measurement.

1.3.1.6 Underwriters Laboratories UL 1283 and UL 1449 (most recent edition).

1.3.1.7 Canadian Standards (CUL).

1.3.1.8 Canadian Standards Association (CSA) CSAC22.2-Latest Edition.

1.3.1.9 Ontario Hydro Electrical Safety Code Latest Edition.

1.4 PRODUCT SHOP DRAWING DATA

1.4.1 Product data shall be submitted in accordance with Section 26 05 01, Electrical General Provisions. This shall include schematic diagram and all options including indicating lights and dry contacts.

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1.4.2 Evidence of compliance to the certifications as per CSA and UL 1449 must be submitted. Manufacturer shall submit the NEMA LS-11992 test results. This will show actual test data as certified by UL and ANSI standard. Documentation must include copy of UL Listing Report. Manufacturer shall certify stating that tested product (UL tests) and delivered product both had same suppliers for raw materials and same processes to manufacture.

1.5 SUBMITTALS

1.5.1 Product Data: Provide catalogue sheets showing voltage, physical size, Measured Limited Voltage for each waveform listed, UL1449 latest revision, latest edition, suppressed voltage ratings, dimensions showing construction, lifting and support points, enclosure details, per mode and per phase peak surge current, modes of discrete suppression circuitry, warranty period and replacement terms, conductor size, conductor type and lead length.

1.5.1.1 Short Circuit Current Rating (SCCR)

1.5.1.2 Voltage Protection Ratings (VPRs) for all modes

1.5.1.3 Maximum Continuous Operating Voltage rating (MCOV)

1.5.1.4 I-nominal rating (I-n)

1.5.1.5 SPD shall be UL listed and labeled as Type 2 or Type 4 intended for Type 2 applications

1.5.2 Submit product data for all components and accessories.

1.5.3 Manufacturer's Installation Instructions: use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product. Indicate maximum size of circuit breaker or fuse to be connected for each unit.

1.5.4 List and detail all protection systems such as fuses, disconnecting means and protective features.

1.5.5 Provide verification that the SPD device complies with the required UL1449 latest edition, latest revision, and CSA approvals.

1.5.6 Provide actual let through voltage test data in the form of oscillograph results for the ANSI/IEEE C62.41 Category C3 & C1 (combination wave) and A1 (ringwave) tested in accordance with

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ANSI/IEEE C62.45.

- 1.5.7 Provide spectrum analysis of each unit based on MIL-STD-220A test procedures between 10 khz and 100 khz verifying the devices noise attenuation equals or exceeds 50 db at 100 khz.
- 1.5.8 Provide test report in compliance with NEMA LS1 from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on both per mode and per phase basis using the IEEE C 62.41, 8x20 microsecond current wave. Test data must be on a complete SPD with internal fusing in place. Test data on an individual module is not acceptable.

1.6 QUALITY ASSURANCE

- 1.6.1 Manufacturer Qualifications: Engage a firm with at least 5 years experience in manufacturing transient voltage surge suppressors.
- 1.6.2 Manufacturer shall be ISO 9001 or 9002 certified.
- 1.6.3 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- 1.6.4 The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.7 DELIVERY, STORAGE, AND HANDLING

- 1.7.1 Handle and store equipment in accordance with manufacturer's Installation and Maintenance Manuals. One (1) copy of this document to be provided with the equipment at time of shipment.

2 **PRODUCTS**

2.1 MANUFACTURERS

- 2.1.1 Provide an internally mounted Surge Protective Devices (SPD) formally called Transient Voltage Suppressor (TVSS) by:
 - 2.1.1.1 Eaton.
 - 2.1.1.2 Schneider

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2.1.1.3 Siemens

2.2 ELECTRICAL DISTRIBUTION EQUIPMENT

2.2.1 Switchboards:

2.2.1.1 SPD shall be UL 1449 labeled as Type 4 intended for Type 2 applications, verifiable at UL.com, without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal over-current and thermal over-temperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.

2.2.1.2 SPD shall be factory installed integral to electrical distribution equipment.

2.2.1.3 Type 4 SPD shall be UL labeled with 20kA I-nominal (I-n)

2.2.1.4 SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR).

2.2.1.5 Standard 7 Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.

2.2.1.6 SPD shall be connected to the buss of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect.

2.2.1.7 SPD shall meet or exceed the following criteria:

2.2.1.7.1 Maximum 7-Mode surge current capability shall be 200kA or higher per phase.

2.2.1.7.2 UL 1449 - Third Edition Revision; effective September 29, 2009, where applicable either Type 2 or Type 4 Voltage Protection Ratings shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L	MCOV
208/120V	800V	800V	800V	1200V	150V
480/277V	1200V	1200V	1200V	2000V	320V
600/347V	1500V	1500V	1500V	2500V	420V

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2.2.1.8 UL 1449 Listed Maximum Continuous Operating Voltage (MCOV)

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208/120V	25%	150V
600/347V	20%	420V

2.2.1.9 SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of - 50dB at 100 kHz.

2.2.1.10 Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.

2.2.1.11 SPD shall include a serviceable, replaceable module.

2.2.1.12 SPD shall be equipped with the following diagnostics:

2.2.1.12.1 Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.

2.2.1.12.2 Audible alarm with on/off silence function and diagnostic test function.

2.2.1.12.3 Form C dry contacts

2.2.1.12.4 Optional – Surge Counter

2.2.1.12.5 No other test equipment shall be required for SPD monitoring or testing before or after installation.

2.2.1.13 SPD shall have a response time no greater than 1/2 nanosecond.

2.2.1.14 SPD shall have a 10 year warranty.

2.2.2 Distribution Panels:

2.2.2.1 SPD shall be UL 1449 labeled as Type 4 intended for Type 2 applications, verifiable at UL.com, without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal over temperature controls. SPDs relying

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upon external or supplementary installed safety disconnectors do not meet the intent of this specification.

- 2.2.2.2 SPD shall be factory installed integral to electrical distribution equipment.
- 2.2.2.3 Type 4 SPD shall be UL labeled with 20kA I-nominal (I-n)
- 2.2.2.4 SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR).
- 2.2.2.5 Standard 7 Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
- 2.2.2.6 SPD shall be connected to the buss of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect.
- 2.2.2.7 SPD shall meet or exceed the following criteria:
 - 2.2.2.7.1 Maximum 7-Mode surge current capability shall be 150kA or higher per phase
 - 2.2.2.7.2 UL 1449 - Third Edition Revision; effective September 29, 2009, where applicable either Type 2 or Type 4 Voltage Protection Ratings shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L	MCOV
208/120V	800V	800V	800V	1200V	150V
480/277V	1200V	1200V	1200V	2000V	320V
600/347V	1500V	1500V	1500V	2500V	420V

- 2.2.2.8 UL 1449 Listed Maximum Continuous Operating Voltage (MCOV)

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208/120V	25%	150V
600/347V	20%	420V

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- 2.2.2.9 SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of - 50dB at 100 kHz.
- 2.2.2.10 Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.
- 2.2.2.11 SPD shall include a serviceable, replaceable module.
- 2.2.2.11.1 SPD shall be equipped with the following diagnostics:
- 2.2.2.11.2 Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
- 2.2.2.12 Audible alarm with on/off silence function and diagnostic test function (excluding branch).
- 2.2.2.12.1 Form C dry contacts
- 2.2.2.12.2 Optional – Surge Counter
- 2.2.2.12.3 No other test equipment shall be required for SPD monitoring or testing before or after installation.
- 2.2.2.12.4 SPD shall have a response time no greater than 1/2 nanosecond.
- 2.2.2.12.5 SPD shall have a 10 year warranty.
- 2.2.2.13 Branch Panels:
- 2.2.2.14 The panelboard shall be CSA C22.2 No.29 certified and the SPD shall be UL 1449 labeled as Type 4 intended for Type 2 applications.
- 2.2.3 The unit shall be top or bottom feed according to requirements. A circuit directory shall be located inside the door.
- 2.2.3.1 SPD shall meet or exceed the following criteria:
- 2.2.3.2 Maximum 7-Mode surge current capability shall be 100kA or higher per phase.
- 2.2.3.3 UL 1449 - Third Edition Revision; effective September 29, 2009, where applicable either Type 2 for Canada (or Type 1 for US) or Type 4 Voltage Protection Ratings shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L	MCOV

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208/120V	800V	800V	800V	1200V	150V
480/277V	1200V	1200V	1200V	2000V	320V
600/347V	1500V	1500V	1500V	2500V	420V

2.2.3.4 UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208/120V	25%	150V
600/347V	20%	420V

2.2.3.5 SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of - 50dB at 100 kHz.

2.2.3.6 Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.

2.2.3.7 SPD shall include a serviceable, replaceable module.

2.2.3.8 SPD shall be equipped with the following diagnostics:

2.2.3.8.1 Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.

2.2.3.8.2 Audible alarm with on/off silence function and diagnostic test function.

2.2.3.8.3 Form C dry contacts

2.2.3.8.4 Optional – Surge Counter

2.2.3.8.5 No other test equipment shall be required for SPD monitoring or testing before or after installation.

2.2.3.9 SPD shall have a response time no greater than 1/2 nanosecond.

2.2.3.10 SPD shall have a 10 year warranty.

2.2.3.11 The unit shall have removable interior.

2.2.3.12 The main bus shall be copper or aluminum and rated for the load

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current required.

- 2.2.3.13 The unit shall include a 200% rated neutral assembly with copper neutral bus.
- 2.2.3.14 The unit shall be provided with a safety ground bus.
- 2.2.3.15 The field connections to the panelboard shall be main lug or main breaker.
- 2.2.3.16 The unit shall be constructed with flush or surface mounted trim and shall be in a Sprinkler proof enclosure.

3 **EXECUTION**

3.1 INSTALLATION

- 3.1.1 Install per manufacturer's recommendations and contract documents.

3.2 ADJUSTMENTS AND CLEANING

- 3.2.1 Remove debris from installation site and wipe dust and dirt from all components.
- 3.2.2 Repaint marred and scratched surfaces with touch up paint to match original finish.

3.3 TESTING

- 3.3.1 Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacture's recommendations.
- 3.3.2 Check all installed panels for proper grounding, fastening and alignment.

3.4 WARRANTY

- 3.4.1 Equipment manufacturer warrants that all goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation, but not more than eighteen months from date of shipment.

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END OF SECTION

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1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results - Electrical.

1.1.2 Conform to relevant sections of specification for this and other Divisions.

1.2 REFERENCES

1.2.1 ANSI C82.4-1985, Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps.

1.2.2 CGSB 31-GP-103Ma, Heavy Phosphate Conversion Coatings for Iron and Steel (for Corrosion Resistance).

1.2.3 CGSB 31-GP-105Ma, Zinc Phosphate Conversion Coatings for Paint Base.

1.2.4 CGSB 31-GP-106M, Coating, Conversion, Iron Phosphate, for Paint Base.

1.3 SHOP DRAWINGS AND PRODUCT DATA

1.3.1 Submit shop drawings in accordance with Section 01 33 00 - Submittals.

1.3.2 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for approval and review by Engineer.

1.3.3 Photometric reports shall include lamp-type used, reflection values used, mounting height of all fixtures, and all associated light loss factors for each fixture type, along with the name and contact information of designer who prepared calculations.

1.3.4 Photometric data to include recommended spacing criterion.

1.4 JOB MOCK-UP

1.4.1 Submit mock-ups in accordance with Section 01400 - Quality Control.

1.4.2 Install sample fixtures of the type(s) indicated in the luminaire schedule, in mock-up ceiling. Do include cost of mock-up in project

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price. Locate mock-up on site.

1.5 WASTE MANAGEMENT AND DISPOSAL

- 1.5.1 Separate and recycle waste materials in accordance with section 26 05 10 – Electrical Demolition.
- 1.5.2 Place materials defined as hazardous or toxic waste in designated containers.
- 1.5.3 Ensure emptied containers are sealed and stored safely for disposal away from children.
- 1.5.4 Disposal of fluorescent lamps shall be in accordance with local regulations. Wherever possible, fluorescent lamps shall be recycled by authorized recycling company.
- 1.5.5 Disposal of old PCB filled ballasts (if still existing) on renovation jobs shall be in accordance with regulations of authorities having jurisdiction.

2 **PRODUCTS**

2.1 LAMPS

2.1.1 Fluorescent lamps

Lamp Design	Bulb Shape Wattage	Base	Type	Initial Lumens	Life Hrs.	Descrip.	Colour K
	T8-32W	md.bip	RS	2950	20000		
	T5-28W	min.bip	PRS	2900	20000	neutral	3500
	T5HO-54W	min.bip	PRS	5000	20000	white neutral white	3500

2.1.2 LED Systems

- 2.1.2.1 Luminaire photometric report published by manufacturer will be based on LM- 79-08 (IESNA).
- 2.1.2.2 Data pertaining to the temperature (such as solder joint temperature) for the LEDs when operated inside the luminaire in the intended application; and information about how the measured

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temperature relates to expected life of the system will be provided.

- 2.1.2.3 Any test data available about longer term performance of the LED luminaire, such as DOE CALiPER testing, manufacturer in-house testing, or field tests conducted by DOE, utilities, or other parties will be provided.
- 2.1.2.4 Life Rating will be based on LM-80-08 (IESNA) . It will be defined as number of hours of operation where at least 70% of initial lumens for LEDs is maintained.
- 2.1.2.5 CRI should be greater than 80 (chromaticity as per ANSI C78.377-2008).
- 2.1.2.6 Mock up should be done before execution of the project.
- 2.1.2.7 Power supplies and control interfaces should be suitable/compatible with the LED modules/luminaires.
- 2.1.2.8 Input voltage for power supply will be 120v.
- 2.1.2.9 Ambient temperature -20 deg C to +50 deg C.
- 2.1.2.10 FCC 47CFR Part 15 compliant.
- 2.1.2.11 LED systems to be RoHS compliant.
- 2.1.2.12 Wiring to be as per the manufacturer's data sheet and to comply with local codes/standards.
- 2.1.3 Environmental Impact
 - 2.1.3.1 All lamps shall be recyclable and have low mercury content, as determined by the Federal Toxic Characteristic Leaching Procedure (TCLP) testing procedure.
- 2.2 BALLASTS
 - 2.2.1 Fluorescent ballast: CBM and CSA certified, energy efficient type, IC electronic and IC electronic dimmable where required.
 - 2.2.1.1 Rating: 347V, 60 Hz voltage as indicated, for use with 2-32 W, rapid start lamps.
 - 2.2.1.2 RFI/EMI suppression circuit.
 - 2.2.1.3 Totally encased and designed for 104°F (40°C) ambient

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temperature.

- 2.2.1.4 Power factor: minimum 95% with 95% of rated lamp lumens.
- 2.2.1.5 Crest factor: 1.7 maximum current, 2.0 maximum voltage.
- 2.2.1.6 Capacitor: thermally protected.
- 2.2.1.7 Thermal protection: [non-resettable] on coil.
- 2.2.1.8 Harmonics: 10% maximum THD, including 49th for electronic discrete and hybrid ballasts.
- 2.2.1.9 Operating frequency of fluorescent electronic ballast: 20kHz or greater.
- 2.2.1.10 Sound rated: A.
- 2.2.1.11 Mounting: integral with luminaire unless otherwise specified.
- 2.2.2 Metal halide ballast: design parallel
 - 2.2.2.1 Rating: 347 V, 60 Hz voltage as indicated, for use with 1-400 W metal halide lamp. Provide circuitry for standby light to provide light for starting and restart.
 - 2.2.2.2 Totally encased and designed for 104°F (40°C) ambient temperature.
 - 2.2.2.3 Power factor: minimum 95% with 95% of rated lamp lumens.
 - 2.2.2.4 Type: constant wattage auto-transformer.
 - 2.2.2.5 Input voltage range: plus or minus 10% of nominal.
 - 2.2.2.6 Minimum starting temperature: minus 84°F (29°) at 90% line voltage.
 - 2.2.2.7 Mounting: integral with luminaire, unless otherwise specified.
 - 2.2.2.8 Crest factor: 1.8 maximum current, 2.0 maximum voltage.
- 2.3 FINISHES
 - 2.3.1 Baked enamel finish:
 - 2.3.1.1 Conditioning of metal before painting:

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- 2.3.1.1.1 For corrosion resistance conversion coating to CGSB 31-GP-103Ma.
- 2.3.1.1.2 For paint base, conversion coating to CGSB 31-GP-105Ma, CGSB 31-GP-106M.
- 2.3.1.2 Metal surfaces of luminaire housing and reflectors finished with high gloss baked enamel or polyester powder coat to give smooth, uniform appearance, free from pin holes or defects.
- 2.3.1.3 Reflector and other inside surfaces finished as follows:
 - 2.3.1.3.1 White, minimum reflection factor 85%.
 - 2.3.1.3.2 Colour fastness: yellowness factor not above 0.02 and after 250 h exposure in Atlas fade-ometer not to exceed 0.05.
 - 2.3.1.3.3 Film thickness, not less than 0.03 mm average and in no areas less than 0.025mm.
 - 2.3.1.3.4 Gloss not less than 80 units as measured with Gardner 60 gloss meter.
 - 2.3.1.3.5 Flexibility: withstand bending over (12 mm) ½" mandrel without showing signs of cracking or flaking under ten (10) times magnification.
 - 2.3.1.3.6 Adhesion: (24 mm) 1" square lattice made of (3 mm) 1/8"-square cut through film to metal with sharp razor blade. Adhesive cellulose tape applied over lattice and pulled. Adhesion satisfactory if no coating removed.
- 2.3.2 Alzak finish:
 - 2.3.2.1 Aluminum sheet fabricated from special aluminum alloys and chemically brightened, subsequently anodically treated to specifications established by Alcoa, to produce:
 - 2.3.2.1.1 Finish for mild commercial service, minimum density of coating 7.8 g/m, minimum reflectivity 83% for specular, 80.5% for semi-specular and 75% for diffuse.
 - 2.3.2.1.2 Finish for regular industrial service, minimum density of coating 14.8 g/m, minimum reflectivity 82% for specular and 73% for diffuse.
 - 2.3.2.1.3 Finish for heavy duty service, minimum density of coating 21.8

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g/m, minimum reflectivity 85% for specular, 65% for diffuse.

2.4 LIGHT OPTICAL CONTROL DEVICES

- 2.4.1 Plastic for clear lenses and diffusers shall be manufactured from injection-molded clear virgin acrylic, unless otherwise noted.
- 2.4.2 Glass used for lenses, refractors, and diffusers shall be tempered for high impact and heat resistance. For exterior fixtures use tempered Borosilicate glass.
- 2.4.3 Generally, lenses shall be 0.125" (3.18mm) thick overall with 0.084" (2.13mm) maximum penetration in a K-12 pattern unless otherwise noted.
- 2.4.4 Provide ultraviolet inhibited lenses and shields over lamps as indicated.

2.5 LUMINAIRE CONSTRUCTION

- 2.5.1 Unless otherwise indicated, luminaire bodies shall be of minimum 20-gauge (0.0359" thick), cold rolled prime steel of rigid construction with knockouts as required.
- 2.5.2 Fixture rigidity shall permit any suspension method without sag. Fluorescent luminaires shall be suitable for either individual or continuous mounting.
- 2.5.3 Fixtures shall be finished in baked white enamel unless otherwise noted, with exposed surfaces matching the exposed tee bars specified in other sections and shall resist chipping, corrosion, and discolouration
- 2.5.4 Fixture lenses and diffusers shall be rigid enough to be self-supporting without sag, easily removable but not loose. Provide additional thickness of lens to prevent sag at no extra cost to the owner.
- 2.5.5 Where the architect is to select colours and finish of luminaires after award of contract, it shall be the responsibility of the contractor for Division 26 to obtain this information well in advance of installation schedule.
- 2.5.6 Where fixtures are specified to have two separate power sources within, provide all necessary barriers, etc., to isolate the two power sources as per the requirements of the authorities having jurisdiction.

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- 2.5.7 Where fixtures are located in sound-critical spaces including but not limited to theater, multi-purpose room, as described in noise section shall be mounted with rubber cushion or assemblies provide necessary isolation barrier.
- 2.5.8 Where fixtures are specified to be IP65 rated, rating shall be tested to IEC 60598 by a recognized independent testing authority.
- 2.6 MANUFACTURERS
- 2.6.1 The listing of a manufacturer as "acceptable" does not imply automatic approval. It is the responsibility of the contractor to ensure that any price quotations received and submittals made are for devices that meet or exceed the specifications included herein.
- 2.6.2 Refer to Luminaire Schedule for the acceptable manufacturers for the specific luminaire types.
- 2.7 LAMPS:
- 2.7.1 Sylvania, or Philips unless otherwise specified. The same manufacturer shall supply all lamps of a given type.
- 2.7.2 Ballasts:
- 2.7.2.1 Advance.
- 2.7.2.2 GE/Universal/Magnetek
- 2.7.2.3 Osram Sylvania
- 2.7.2.4 Fluorescent dimming ballasts shall be Lutron only.
- 2.7.2.5 Hatch electronics shall be equal on electronic metal halide ballasts.
- 2.7.3 Luminaires:
- 2.7.3.1 The catalog number, if provided, is for reference only and may not include all options and features required by the description. Manufacturer/supplier to ensure the submitted luminaire meet all requirements identified in each luminaire schedule.
- 2.7.3.2 Include cost for aiming and adjustment(s) of luminaires, programming, dimming setting, LV lighting control adjustment(s), etc. as part of this contract.
- 2.7.3.3 Where several manufacturers are shown, the first one named,

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accompanied by a model or catalog number, is the one on which the design is based.

2.7.3.4 The presence of a manufacturer's name as an acceptable alternate indicates acceptance of that manufacturer's level of quality, but does not imply that a comparable luminaire by that manufacturer necessarily exists and/or equivalent.

2.7.3.5 The products of the other named manufacturers may be used, provided that the product offered meets the specification, is visually similar to, and has photometric performance comparable to, the first-named product. The manufacturer/supplier shall be responsible to review the base luminaire and make the final determination as to whether the product of an alternative manufacturer meets the above criteria. In the event that such product is deemed not to meet those criteria, the manufacturer/supplier shall provide the product on which the design was based.

2.7.3.6 All luminaires will be specification grade. Do not provide luminaires that are not similar in shape and/or not equivalent. It is the responsibility of the manufacturer/ supplier to ensure compliance.

2.8 OWNER'S SPARE STOCK (ADDENDUM E-1)

2.8.1 Provide 2% of all luminaires, lamps, ballasts, and drivers as installed on this project for Owner's attic stock. The spare stock products shall be handed over to the Owner in their original packaging prior to the substantial completion of the project.

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Replace all lamps with new, if there is any rapid deterioration of lamps which the Consultant views as excessive in terms of the project warranty, at no cost to the Owner.

3.1.2 Replace all lamps with a colour shift which does not correlate to manufacturers published data.

3.1.3 Locate and install luminaires as indicated.

3.2 WIRING

3.2.1 Connect luminaires to lighting circuits:

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3.2.1.1 Through flexible conduit or modular wiring system.

3.3 LUMINAIRE SUPPORTS

3.3.1 For suspended ceiling installations, support luminaires independently of ceiling, duct work, or piping.

3.4 LUMINAIRE ALIGNMENT

3.4.1 Align luminaires mounted in continuous rows to form straight uninterrupted line.

3.4.2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

3.4.3 Install pendant lighting fixtures plumb and at a height from the floor as specified on drawings/specifications. In cases where conditions make this impractical, refer to the Architect for decision. Use ball aligners and canopies on pendant fixtures unless noted otherwise.

3.5 CLEANUP

3.5.1 All lighting fixtures shall be thoroughly cleaned with materials and methods recommended by the manufacturers. All broken parts shall have been replaced and all lamps shall be operative.

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: Unit Equipment for Emergency Lighting
Section No.: 26 52 01
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1 GENERAL

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 Common Work Results - Electrical.

1.1.2 Conform to relevant sections of specification for this and other Divisions.

1.2 PRODUCT DATA

1.2.1 Submit product data in accordance with Section 01 33 00 – Submittals.

1.2.2 Data to indicate system components, mounting method, source of power and special attachments.

2 PRODUCTS

2.1 EQUIPMENT

2.1.1 Supply voltage: 120 V, ac.

2.1.2 Output voltage: 24V dc.

2.1.3 Operating time: 120 min.

2.1.4 Battery: sealed, maintenance free.

2.1.5 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.

2.1.6 Solid state transfer circuit.

2.1.7 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.

2.1.8 Signal lights: solid state, for AC Power ON, and High Charge.

2.1.9 Lamp heads: integral on unit and remote as indicated on the floor plans, 345 horizontal and 180 vertical adjustment. Lamp type: LED 12W.

2.1.10 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy

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access to batteries.

2.1.11 Finish: To be selected by the Architect from standard options.

2.1.12 Auxiliary equipment:

2.1.12.1 Ammeter.

2.1.12.2 Voltmeter.

2.1.12.3 Test switch.

2.1.12.4 Time delay relay.

2.1.12.5 Battery disconnect device.

2.1.12.6 Ac input and dc output terminal blocks inside cabinet.

2.1.12.7 Cord and duplex receptacle plug connection for ac.

2.1.12.8 RFI suppressors.

2.2 WIRING OF REMOTE HEADS

2.2.1 Conduit: To Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

2.2.2 Conductors: To Section 26 05 21 - Wires and Cables0 - 1000 V, sized in accordance with manufacturer's recommendations.

2.3 MANUFACTURER

2.3.1 Acceptable manufacturers are:

2.3.1.1 Beghelli

2.3.1.2 Emergi-lite

2.3.1.3 Lumacell

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Install unit equipment and remote mounted fixtures.

3.1.2 Direct heads.

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3.1.3 Connect exit lights to unit equipment.

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Exit Signs**
Section No.: **26 53 00**
Date: August 30, 2024

1 **GENERAL**

1.1 REFERENCE

1.1.1 Read and be governed by Section 26 05 00.

1.2 RELATED WORK

1.2.1 Comply with relevant Sections of this and other Divisions of this Specification.

1.3 PRODUCT DATA

1.3.1 Submit product data in accordance with Section 26 05 00.

1.3.2 Exit Signs based on CSA C22.2 No141

1.3.3 NRCAN/CSA C860 Certified.

2 **PRODUCTS**

2.1 PUBLIC AREAS TYPE

2.1.1 Edge lit type, either single face recessed wall mount, or recessed single or double faced ceiling mount.

2.1.2 Housing to have steel bevelled trim plate, with white finish.

2.1.3 Faceplate to have green pictogram on clear, white or mirrored background, complying to NBC 2010, with or without directional indicators as required.

2.1.4 Lamps to be high output LED, not exceeding 2W power draw, vertically aligned, and parallel proprietary lateral, acrylic lens, such that they are fully contained and not be visible or protruding.

2.1.5 Self-powered unit for 120V input with dust-tight relay transfer and maintenance free nickel cadmium battery. Include low voltage disconnect, short circuit, reverse polarity test switch, high charge, and brownout protection features.

2.1.6 Edgelit sign to be Beghelli GUIDA RM series or approved equal.

2.2 BACK OF THE HOUSE AND SERVICE AREAS TYPE

2.2.1 Thin line type with a maximum depth of 51 mm (2"), surface, single or double face, end or ceiling mounted.

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- 2.2.2 Housing to be fully extruded aluminum, with matt white finish.
- 2.2.3 Faceplate to be green pictorial sign complying to NBC 20 12 stand and with or without directional indicators as required.
- 2.2.4 Lamps to be high output LED not exceeding 2W power draw, vertically aligned, and parallel proprietary lateral, acrylic lens, such that they are fully contained and not be visible or protruding.
- 2.2.5 Pictorial exit sign shall be Beghelli QUADRA series or approved equal.

2.3 GENERAL

- 2.3.1 All exit lights shall have :
 - 2.3.1.1 Have no light leakage from joints and fittings.
 - 2.3.1.2 Have canopy and/or stem hangers to match housing.
 - 2.3.1.3 Meet the requirements of standard CSA C860.
 - 2.3.1.4 Must be 2010 NBC compliant

3 **EXECUTION**

3.1 INSTALLATION

- 3.1.1 Install exit lights where shown.
- 3.1.2 Connect exit lights to circuits as indicated.
- 3.1.3 Ensure that exit light circuit breaker is locked in ON position.
- 3.1.4 Ensure that nowhere, are exit lights mounted less than 2m (6'-6") between underside of unit and finished floor.
- 3.1.5 For ceiling mounting in areas with unfinished ceiling, mount unit alongside junction box, with or without canopy, and supply unit laterally with conduit (or with buried conduit, where allowed or specified, or by using the exit light canopy as a junction box where approved).

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- 3.1.6 Include in the Bid, for the installation of 5 (five) additional exit lights of each type X1 where directed on site.

END OF SECTION

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 Section Name: **List of Acceptable Manufacturers**
 Section No.: **26 90 00**
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List of Acceptable Manufacturers

SPECIFICATION SECTION	EQUIPMENT	ACCEPTABLE MANUFACTURERS
26 05 19 Low-voltage Electrical Power Conductors and Cables	Building Wires	<ul style="list-style-type: none"> • General Cable • SouthWire • Nexans • Canada Wire and Cable
	Type TECK90 Cable	<ul style="list-style-type: none"> • General Cable • SouthWire • Nexans • United Wire and Cable
	Armoured Cables	<ul style="list-style-type: none"> • General Cable • SouthWire • Nexans
	Mineral-Insulated Cables	<ul style="list-style-type: none"> • nVent - Pyrotenax
	Fire-Rated Power Cables	<ul style="list-style-type: none"> • nVent – Pyrotenax • Vitalink
	Control Cables	<ul style="list-style-type: none"> • General Cable • SouthWire • Nexans • United Wire and Cable • Belden • Delco
	Drive RX Cables for Variable Frequency Drives Application	<ul style="list-style-type: none"> • General Cable • SouthWire • Nexans
26 05 20 Wiring and Box Connectors 0-1000V	Standard Fixed Spring Type Connectors	<ul style="list-style-type: none"> • Thomas & Betts: Marrett Type II Winged • Ideal Industries
	Vibration Resistant and High Temperature	<ul style="list-style-type: none"> • Thomas and Betts: Marrett Set Screw

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	Sleeve & Screw Type Connectors	Vibration Proof/Visible Connector <ul style="list-style-type: none"> • Ideal Industries
	Weatherproof Fixed Spring Type Connectors	<ul style="list-style-type: none"> • Ideal Industries: Weatherproof Wire Connector
	Mechanical Wire Connectors	<ul style="list-style-type: none"> • Panduit: Pan-Lug Cast Copper Connectors • Blackburn
	Compression Wire Connectors	<ul style="list-style-type: none"> • Panduit: Pan-Lug Compression Connectors • Blackburn
	Mechanical Lugs	<ul style="list-style-type: none"> • Panduit: Pan-Lug Aluminum Mechanical Connectors • Blackburn
	Insulated Butt (Hypress) Splice	<ul style="list-style-type: none"> • Panduit: Pan-Term Butt splice • 3M • Blackburn
26 05 29 Hangers and Supports for Electrical Systems	Support Channels	<ul style="list-style-type: none"> • Unistrut of Canada Ltd. • Burndy Canada Ltd. • Electrovert Ltd. • Pilgrim Technical Products Limited
	Concrete Anchors	<ul style="list-style-type: none"> • Hilti Canada Ltd • Pilgrim Technical Products Limited • Electrovert Ltd. • Unistrut
26 05 33.23 Surface Raceways for Electrical Systems	Surface Floor Raceway System	<ul style="list-style-type: none"> • Legrand: 4000 Series Multi-Channel Metal Raceway

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26 05 36 Cable Trays for Electrical Systems	Cable Trays	<ul style="list-style-type: none"> • Thomas & Betts Canada • Cablofil • Canadian Electrical Raceways • Eaton B-Line
26 05 73 Short Circuit System Coordination & Arc Flash Study	Short Circuit System Coordination and Arc Flash Study	<ul style="list-style-type: none"> • Eastenghouse • Brosz and Associates • Enkompass • GT Wood • Pelikan • Schneider • Eaton
26 09 13 Power Monitoring	Power Monitoring	<ul style="list-style-type: none"> • Intellimeter Canada • Quadlogic Controls Corp • Carma Industries • Shneider Electric • Eaton Electric
26 09 23 Lighting Control Devices	General 0-10V Dimmers	<ul style="list-style-type: none"> • Lutron: DIVA or equivalent • Acuity: nLight • Leviton (Specification Grade)
	General Occupancy Sensors	<ul style="list-style-type: none"> • Lutron • Acuity: Sensor Switch • Watt Stopper • Leviton (Specification Grade)
26 22 13 Dry Type Transformers up to 600V Primary	Dry Type Transformers	<ul style="list-style-type: none"> • Hammond Power Solutions • Schneider Electric – Square D • Rex Power Magnetics • Delta • STI

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26 24 13 Switchboard	Switchboards	<ul style="list-style-type: none"> • Schneider Electric – Square D • Eaton – Cutler Hammer • Siemens
26 24 16 Panelboards	Panelboards	<ul style="list-style-type: none"> • Schneider Electric – Square D • Eaton – Cutler Hammer • Siemens
26 27 26 Wiring Devices	Wiring Devices	<ul style="list-style-type: none"> • Hubbell Canada • Pass & Seymour • Leviton (Specification Grade)
26 28 16.01 Moulded Case Circuit Breakers	Moulded Case Circuit Breakers	<ul style="list-style-type: none"> • Schneider Electric – Square D • Eaton – Cutler Hammer • Siemens
26 28 23 Disconnect Switches Fused & Non-fused	Disconnect Switches	<ul style="list-style-type: none"> • Schneider Electric – Square D • Eaton – Cutler Hammer • Siemens
26 36 23 Automatic Load Transfer Switch	Automatic Load Transfer Switch	<ul style="list-style-type: none"> • ASCO: 7000 Series • Eaton
26 43 13 Surge Protective Devices	Surge Protective Devices	<ul style="list-style-type: none"> • Schneider • Eaton • Siemens
26 52 01 Unit Equipment for Emergency Lighting	Unit Equipment for Emergency Lighting	<ul style="list-style-type: none"> • Beghelli • Emergi-Lite • Lumacell

SECTION 27 05 00	COMMON WORK RESULTS FOR COMMUNICATIONS
SECTION 27 05 36	CABLE TRAYS FOR COMMUNICATIONS SYSTEMS
SECTION 27 05 53	IDENTIFICATION FOR COMMUNICATIONS SYSTEMS
SECTION 27 08 00	COMMUNICATIONS SYSTEM CX
SECTION 27 11 16	COMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES
SECTION 27 11 19	COMMUNICATIONS TERMINATION BLOCKS & PATCH PANELS
SECTION 27 11 26	COMMUNICATIONS RACK-MOUNTED POWER PROTECTION & POWER STRIPS
SECTION 27 15 13	COMMUNICATIONS COPPER HORIZONTAL CABLING
SECTION 27 15 33	COMMUNICATIONS COAXIAL HORIZONTAL CABLING
SECTION 27 15 43	COMMUNICATIONS FACEPLATES AND CONNECTORS
SECTION 27 16 19	COMMUNICATIONS PATCH CORDS, STATION CORDS, AND CROSS-CONNECT WIRE
APPENDIX A	CITY OF TORONTO – COMMERCIAL FACILITIES STRUCTURED CABLING SYSTEMS DESIGN GUIDE FOR CONSULTING ENGINEERS, ARCHITECTS, DESIGNERS & CONTRACTORS - REVISION 1.0, JANUARY 2023

PART 1: REQUIREMENTS**1.1 GENERAL CONTRACT DOCUMENTS**

- .1 Comply with General Conditions of Contract, Supplementary Conditions and Division 01, 25, 26, 27, 28

1.2 SECTION INCLUDES

- .1 The purpose of this document is to provide a performance specification for a new Structured Cabling System following the standards for The City of Toronto.
- .2 This specification will outline the requirements for the scope areas, products, components, materials, and configuration of products.
- .3 This document details the system functional and performance requirements, and required submittals, testing/commissioning /certification procedures and installation procedures for all parts of the Structured Cabling System.
- .4 The Communications Cabling Contractor shall be a certified partner in good standings by the manufacturer of the Cabling solution being installed.
- .5 Refer to schedule for milestones and project completion date.

1.3 WORK INCLUDED

- .1 Work to be done under this section includes the furnishing of labour, materials, equipment, software, integration and services required for installation, testing and putting into proper operation complete systems as shown, as specified, as intended, and as otherwise required. Complete systems to be left configured to Owner's desired settings and ready for continuous and efficient satisfactory operation.
- .2 Coordinate with Owner, Consultant, Architect and other trades as necessary to ensure systems are provided with appropriate services, supports, finishes and integration.
- .3 Integrate, test and commission systems as specified.

1.4 DOCUMENT ORGANIZATION

- .1 The specification applies to the following:
 - .1 Division 27 – Communications and Audiovisual. See Separate 27 40 00 Specifications for Audiovisual.
 - .2 Division 28 - Electronic Safety and Security
- .2 Comply with the requirements of Division 26.
- .3 For clarity, any reference in the Contract Documents to Division 27 includes Division 28 unless otherwise indicated.
- .4 The Specifications for these Divisions are arranged in Sections for convenience. It is not intended to recognize, set or define limits to any subcontract or to restrict Contractor in letting subcontracts.
- .5 Contractor is responsible for completion of the Work whether or not portions are sublet.

1.5 DEFINITIONS

- .1 The words "indicated", "shown", "noted", "listed" or similar words or phrases used in these Specifications, mean that the material or item referred to is "indicated", "shown", "listed" or "noted" on the Drawings or in the Specifications.
- .2 The words "approved", "satisfactory", "as directed", "submit", "permitted", "inspected", or similar words or phrases used in these Specifications, mean that the material or item referred to, is to be "approved by", "satisfactory to", "as directed by", "submitted to", "permitted by", "inspected by" the Consultant.
- .3 Instructions using any form of the word "provide", requires the Contractor to furnish labour, materials and services as necessary to supply and install the referenced item.
- .4 The term "building code" means the current edition of the "Ontario Building Code".
- .5 The terms "electrical code" and "electrical safety code" mean the current edition of the "Ontario Electrical Safety Code".
- .6 The term "AHJ" means the "Authority Having Jurisdiction" and can include the local building inspector, the local fire department and the electrical safety inspector or their agents.
- .7 The definitions, acronyms, abbreviations and units of measure defined in TIA-568.1-D apply to these specifications.
- .8 The following acronyms are used:

Table 1 : Acronyms			
acronym	Definition	acronym	Definition
API	Application Program Interface	SDK	Software Development Kit
IP	Internet Protocol	RAID	Redundant Array of Independent Disks
GUI	Graphical User Interface	COTS	Commercial Off The Shelf
MTBF	Mean Time Between Failures	MTTR	Mean Time To Repair
MTBO	Mean Time Between Outages	RAM	Random Access Memory
TBC	Telecommunications Bonding Conductor	EMI	Electromagnetic Interference
BICSI	Building Industry Consulting Service International	EMT	Electrical Metallic Tubing or thin wall conduit
OEM	Original Equipment Manufacturer	STP	Shielded Twisted Pair
PA	Public Address System	PBB	Telecommunications Primary Bonding Busbar
PBX	Private Branch Exchange	UPS	Uninterruptible Power Supply
PoE	Power over Ethernet	UTP	Unshielded Twisted Pair
PSTN	Public Switched Telephone Network	LAN	Local Area Network
RF	Radio Frequency (refer to FR)	ISS	Integrated Security System
RU	Rack Unit (rack mounting unit)	AVIXA	Audiovideo and Integrated Experience Association (formerly Infocomm)

SME	Subject Matter Experts	SBB	Telecommunications Secondary Bonding Busbar
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- .9 For additional acronym definitions, refer to ANSI/TIA-569-D-2015: Telecommunications Pathways and Spaces Standards.
- .10 Conveniently Accessible: Capable of being reached without use of ladders, or without climbing or crawling under or over obstacles such as, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.
- .11 Head End (HE): Equipment, hardware and software, or a master facility at originating point in a communications system designed for centralized communications control, signal processing, and distribution that acts as a common point of connection between equipment and devices connected to a system's network of interconnected equipment, possessing greatest authority for allowing information to be exchanged, with which other equipment is subordinate

1.6 EXAMINATION

- .1 Examine any existing buildings and services, local conditions, building site, Specifications, and Drawings and report any condition, defect or interference that would prevent execution of the Work.
- .2 Examine work of other Divisions before commencing the Work, and report any defect or interference.
- .3 No allowance will be made for any expense incurred through failure to make these examinations of the site and documents prior to Tender or on account of any conditions on site or any growth or item existing there which was visible or known to exist at time of Tender

1.7 QUALITY CONTROL

- .1 Manufacturer qualifications:
 - .1 Produce, as a principal product, the equipment and material specified for this project, and have manufactured item for at least three years.
 - .2 Three installations of equipment presently in operation of similar size and type as this project, and that have continuously operated for a minimum of three years;
 - .1 Owner reserves the right to require a list of installations where products have been in operation before approval.
 - .3 Regularly engaged in the manufacture and supply of the system type proposed for this project;
 - .1 Authorized representative of OEM must be responsible for design, satisfactory operation of installed system, and certification.
- .2 Division 27 Contractor qualifications:
 - .1 The City of Toronto's Vendor of Record (Bell Canada) shall be used for all voice and data cabling infrastructure outlined in these specifications:
Roger Vachon – Project Manager BCE
E: roger.vachon@bell.ca
- .3 System supplier qualifications:
 - .1 Authorized by OEM to warranty installed equipment.

- .4 Installer qualifications:
 - .1 Trained, and certified by OEM on installation and testing of system;
 - .1 Provide written evidence of current OEM certifications for installers.
- .5 Manufactured products:
 - .1 Of a single manufacturer when more than one unit of same class of equipment is required.
 - .2 Product shall be manufactured by an ISO 9001 Certified facility.
 - .3 Product shall be free from defects in material or workmanship.
 - .4 Critical manufacturing processes of the product shall have documented in-process inspections and production testing according to ISO 9001.
 - .5 Equipment assemblies and components:
 - .1 Warranty need not be products of same manufacturer.
 - .2 Provide manufacturer's latest version of equipment and upgrade software to latest versions prior to handing over to the Owner.
- .6 Provide manufacturer's warranty on materials, equipment, installation, programming, performance, or workmanship for a period of one year (unless otherwise specified) from date of final acceptance of system by Owner.
- .7 Warranty will be for a period of 20 years, minimum, and will be issued in the name of the Owner, by the OEM Manufacturer. A Contractor Warranty will not be acceptable.
- .8 Include maintenance releases for embedded firmware and operating system and application software during the warranty period.
- .9 Provide OEM contact information to Owner for the purpose of emergency maintenance and logistic assistance, remote diagnostic testing, and assistance in resolving technical problems at any time.
- .10 Repair or replace equipment and/or materials found to be defective during the warranty period.
- .11 Provide approved temporary replacement equipment and materials during repair or replacement such that the system remains fully functional as designed and commissioned.
- .12 Transfer warranties to the Owner upon completion.
- .13 Refer to individual specifications for additional warranty requirements.
- .14 For phased projects, provide additional warranty coverage for operational systems from first substantial use by Owner until completion of project.

PART 2: SUBMITTALS

2.1 PROJECT SCHEDULING

- .1 See overall (GC) project schedule and plan activities in coordination with overall schedule. In addition, coordinate with Prime Consultant, GC, and other Divisions.
- .2 Prepare and submit project schedules for review by Owner's representative.

- .3 Schedules required:
 - .1 Permits
 - .2 Scope of work, including: Project kickoff, weekly and monthly milestones, testing, commissioning, deficiency correction, acceptance, completion
 - .3 Required submittals and review periods
 - .4 Invoicing in accordance with milestones
- .4 Schedule:
 - .1 Dates
 - .2 Scope areas
 - .3 Dependencies
 - .4 Maintain schedules and present impacts and contingencies weekly at construction meetings. Report any changes to Owner's Representative in writing weekly.

2.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings, manufacturers' product data and samples in accordance with Section 01 33 05;
 - .1 Submit for each item of equipment.
 - .2 Submit shop drawings in the same unit of measure as used on the drawings. Both metric and imperial measures may be included.
 - .3 Submit shop drawings by email to Consultant for review
- .2 Include a shop drawing cover sheet form prepared for this project, for each shop drawing, or include the same information on the contractor's submittal cover sheet:
 - .1 Client/Architect name
 - .2 Project Name
 - .3 Project number
 - .4 Date
 - .5 Contractor name
 - .6 Contractor reference No.
 - .7 Manufacturer's name
 - .8 Product type
 - .9 Specifics of product application: area, schedule, function, purpose
 - .10 Specification section number
 - .11 Contractor trade: Electrical, Communications, Security, Audiovisual or general trades

- .12 If a re-submission, the reference number from the previous submission.
- .3 Submit shop drawings in PDF format;
- .4 Manufacturers' printed product data sheets for standard items are acceptable in place of shop drawings provided that physical characteristics are identified and are related to specification references.
- .5 Submit manufacturers' data sheets with typed schedules listing manufacturers' and suppliers' name and catalogue model numbers for such items as components, etc.
- .6 For sub-systems, submit bound sets of sub-system cut sheets with manufacturers' names and catalogue numbers for devices to be used on the project. Identify and arrange the system cut sheets and catalogue numbers in the same sequence as the Specification List.
- .7 Shop drawings and product data to show;
 - .1 CSA,CUL or equivalent approval,
 - .2 Dimensioned outlines of equipment,
 - .3 Dimensioned details showing service connection points.
- .8 Indicate details of construction, dimensions, capacities, weights and functional performance characteristics of equipment or material.
- .9 Where applicable, include;
 - .1 Copies of Contractor, Sub-contractor, vendor, manufacturer, integrator, and installers certifications and qualifications. Include date of issue, individual's legal name, contact information and OEM credentials and contact information in certification.
 - .2 Description of system operation, maintenance and test procedures
 - .3 Equipment catalog sheets with the pertinent specified parameters highlighted,
 - .4 Component assemblies,
 - .5 Fastening and mounting arrangements for devices,
- .10 Each shop drawing to be checked and stamped as being correct, by trade purchasing item, before drawing is submitted. If above requirements are not complied with, shop drawings will be rejected and returned forthwith.

2.3 DRAWINGS

- .1 Include wiring diagrams and installation details of hardware and cables indicating proposed locations, cable dress, conduit, sleeve assignments, layout and arrangements, and other items that must be shown to ensure a coordinated and compliant installation.
- .2 Revise to 'As-Built' at the completion of the project and submit.

2.4 CLOSEOUT

- .1 Submit prior to project closeout date;
 - .1 Manufacturer's warranty certificate.

- .2 Vendor system certifications
- .3 Test results
- .4 As Built drawings
 - .1 As built, and including changes. Submit CAD files. Keep a live set of cable, equipment, and device schedules on site throughout construction.

PART 3: APPLICABLE CODES AND STANDARDS

3.1 GENERAL

- .1 Conform to the requirements of codes and standards referenced herein.
- .2 Comply with the owner's City of Toronto Cabling Standard V4.4 issued with and appended to these specifications.
- .3 Workmanship and materials shall be in full conformance with applicable building, electrical, and other codes, as determined by the authority having jurisdiction (AHJ).
- .4 Unless documents include more stringent requirements, applicable construction industry standards have same force and effect as if bound or copied directly into the documents to extent referenced. Such standards are made a part of these documents by reference.
- .5 Legislation:
 - .1 CSA C22.1 Ontario Electrical Safety Code
- .6 Codes and standards:
 - .1 CSA C22.2 No. 214 Communications Cables
 - .2 CSA 22.2 No. 232 Fibre Optic Cables
 - .3 AC193 Mechanical Anchors in Concrete Elements
 - .4 NEMA VE2 Cable Tray Installation Guidelines
 - .5 NEMA 250 Enclosures for Electrical Equipment (1,000V Maximum)
 - .6 EIA/ECA 310 Cabinets, and Associated Equipment
 - .7 IEEE1100-2005 IEEE Recommended Practice for Powering and Grounding Electronic Equipment
 - .8 ISO/IEC 14763-1:1999 Implementation and Operation of Customer Premises Cabling – Part 1: Administration
 - .9 ANSI/TIA-606-D Administration Standard for Telecommunications Infrastructure.
 - .10 ANSI/TIA-607-D Generic Telecommunications Bonding And Grounding (Earthing) For Customer Premises
 - .11 EN 50310 Telecommunications Bonding Networks for Buildings and other Structures
 - .12 TIA/EIA TSB 67 Transmission Performance Specification for Field Testing of Unshielded Twisted-Pair Cabling Systems

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- .13 TIA/EIA TSB 75 Additional Horizontal Cabling Practices for Open Offices
 - .14 TIA-TSB-184-A Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling
 - .15 TIA-604-10-C FOCIS 10 Fiber Optic Connector Intermateability Standard- Type LC
 - .16 ANSI/TIA/EIA-862-A Building Automation Systems Cabling Standard for Commercial Buildings.
 - .17 ANSI/TIA-568.0-E Generic Telecommunications Cabling for Customer Premises
 - .18 ANSI/TIA-568.1-E Commercial Building Telecommunications Cabling Standard
 - .19 ANSI/TIA-568.2-D Balanced Twisted-Pair Cabling Components
 - .20 ANSI/BICSI N2-17 PoE Installation
 - .21 IEEE 802.3an 10GBASE-T (10 Gb/s Ethernet operations over balanced twisted-pair cabling)
 - .22 TIA-569-E Telecommunications Pathways and Spaces
 - .23 ANSI/TIA-942-A Telecommunications Infrastructure Standard for Data Centers
 - .24 ANSI/BICSI 008-2018 Wireless Local Area Network (WLAN)
 - .25 ANSI/BICSI 001-2017 Educational Facilities Design
 - .26 ANSI/BICSI 002-2014 Data Center Design
 - .27 ANSI/BICSI 003-2014 Building Information Modeling (BIM)
 - .28 ANSI/BICSI 005-2016 Electronic Safety and Security (ESS)
 - .29 ANSI/BICSI 006-2015 Distributed Antenna Systems (DAS)
 - .30 ANSI/BICSI 007-2017 Intelligent Buildings and Premises
 - .31 BICSI G1-17 Outside Plant (OSP) – General
 - .32 BICSI Outside Plant Design Reference Manual (OSPDRM) – Latest Edition
 - .33 ANSI/TIA-758-B Customer-owned Outside Plant Telecommunications Infrastructure Standard
 - .34 BICSI Information Transport Systems Installation Manual (ITSIM) – Latest Edition
 - .35 BICSI Telecommunications Distribution Methods Manual (TDMM) – Latest Edition
 - .36 BICSI Electronic Safety and Security Design Reference Manual
 - .37 ANSI Z136.2 American Standards For the Safe Operation of Fibre Optic Communications Systems Utilizing Laser Diode and LED Sources
 - .38 TIA/EIA TSB72 Centralized Optical Fibre Cabling
 - .39 ANSI/ICEA S-83-596 Fibre Optic Indoor Fibre Cable

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- .40 ANSI/ICEA S-87-640 Fibre Optic Outside Plant Communications Cable
 - .41 ANSI/ICEA S-104-696 Fibre Optic Indoor/Outdoor Communications Cable
 - .42 TIA/EIA/ANSI 598 Colour Coding of Fibre Optic Cables
 - .43 TIA 598-D Optical Fibre Cable Colour Coding
 - .44 TIA/EIA/ANSI 604-3 Fibre Optic Connector Intermateability Standard (FOCIS 3)
 - .45 TIA TSB-140 Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fibre Cabling Systems.
 - .46 TIA-455-C General Requirements for Standard Test Procedures for Optical Fibres, Cables, Transducers, Sensors, Connecting and Terminating Devices, and other Fibre Optic Components
 - .47 TIA-455-61-A Measurement of Fibre Cable Attenuation Using an OTDR
 - .48 TIA-526-7-A Measurement of Optical Power Loss of Installed Single-Mode Fibre Cable Plant
 - .49 TIA TSB-162-B Telecommunications Cabling Guidelines for Wireless Access Points
 - .50 TIA-1152-A Requirements for field test instruments and measurements for balanced twisted-pair cabling
 - .51 TIA-222-H Structural Standard for Antenna Supporting Structures and Antennas
 - .52 ISO 11064, Part 1 - 7 Ergonomic Design of Control Centres
 - .7 Where requirements of this specification exceed those of the above mentioned standards, this specification to govern.
 - .8 In the event of a conflict between codes, regulations, or standards, or where work shown is in conflict with these documents, obtain interpretation before proceeding. Failure to clarify any ambiguity will result in an interpretation requiring the application of the most demanding requirements.

PART 4: EQUIPMENT

4.1 STORAGE

- .1 Store equipment according to manufacturer's instructions and protected from dust, water and other potential contaminants.
- .2 Do not install active equipment until final cleaning is complete.

4.2 DELIVERY, STORAGE, AND HANDLING

- .1 Delivery and Acceptance Requirements:
 - .1 Obtain consultant's approval of submittals for equipment and material before delivery to job site.
 - .2 Deliver, receive, and store materials to job site in OEM's original unopened containers, clearly labeled with OEM's name and equipment catalog numbers, model and serial identification numbers.
- .2 Storage and Handling Requirements:

- .1 Protect equipment and materials during shipment and storage against physical damage, dirt, moisture, cold and precipitation:
- .2 Store and protect equipment in a manner that prevents damage or loss, including theft.
- .3 Protect painted surfaces with factory installed removable heavy kraft paper, sheet vinyl or equivalent.
- .4 Protect enclosures, equipment, controls, controllers, circuit protective devices, and other like items, against entry of foreign matter during installation; vacuum clean both inside and outside before testing and operating.

4.3 PRE-PURCHASED EQUIPMENT, DAMAGE AND OWNERSHIP

- .1 At time of receipt of pre-purchased or pre-tendered equipment at job site by the installing communications contractor, the manufacturer/distributor/supplier's technical representative to be present to inspect the equipment prior to unloading and report any damage to the Consultant. The technical representative to also witness the unloading and advise the Contractor on the appropriate method for handling the equipment in order to avoid damage during unloading, moving, storing and setting in place.
- .2 OTDR testing reports per reel for fibre optics cables to be available to the Contractor and Consultant.
- .3 In the event that the equipment or cabling is found to be damaged before unloading it is to be returned immediately to the factory for repairs and/or replacement by the manufacturer/supplier.
- .4 In the event of damage occurring at any time during unloading and until the equipment is accepted by the Owner, the Contractor is responsible for repairs and/or replacement to the satisfaction of the Owner.

4.4 OWNER-SUPPLIED EQUIPMENT

- .1 In cases where Owner has supplied equipment for installation, test that supplied equipment is in working order upon receipt and notify the owner within seven (7) days if any equipment is not functioning properly. Replacements following this period to be at Contractor's expense.

PART 5: OFFICE, STORAGE & TOOLS

5.1 OFFICE AND STORAGE

- .1 Provide temporary office and lunchroom facilities, workshop, tools and material storage space. Facilities may be site trailers or as otherwise approved by the General Contractor/Construction Manager.
- .2 Assume responsibility for these facilities.
- .3 Provide power, heat, light, telephone, and internet services.
- .4 Owner's cafeteria is off limits.

5.2 APPLIANCES AND TOOLS

- .1 Provide tools, equipment, scaffolding, extension cords, lamps and miscellaneous consumable materials, as required to carry out the Work.

PART 6: COORDINATION

6.1 GENERAL

- .1 Consultant's drawings are diagrammatic and illustrate the general location of equipment, and intended

routing of conduits, cable trays, cables, etc. and do not show every structural detail. In congested areas drawings at greater scale may be provided to improve interpretation of the Work. Where equipment or systems are shown as "double line", they are done so either to improve understanding of the Work, or simply as a result of the use of a CAD drawing tool, and in either case such drawings are not represented as fabrication or installation drawings.

- .2 Lay out and coordinate the Work to avoid conflict with work under other Divisions.
- .3 Make good damage to Owner's property or to other trade's work caused by inaccurate layout or careless performance of the Work.
- .4 Where equipment provided under other Divisions connects with material or equipment supplied under this Division, confirm capacity and ratings of equipment being provided.
- .5 Take information involving accurate measurements from dimensioned Architectural Drawings or at the building.
- .6 Install services and equipment which are to be concealed, close to the building structure so that furring is kept to minimum dimensions.
- .7 Location of conduit, raceways and equipment may be altered without extra cost provided instruction is given or approval is obtained, in advance of installation of items involved. Changes will be authorized by site instructions and are to be shown on Record Drawings.
- .8 Include incidental material and equipment not specifically noted on Drawings or mentioned in Specifications but which is needed to complete the Work as an operating installation.

PART 7: EXECUTION

7.1 PREPARATION

- .1 Verify condition of systems and related sub-systems previously installed under other Sections or Contracts are acceptable for installation and integration in accordance with these Contract Documents and in accordance with manufacturer's written instructions.
 - .1 Visually inspect spaces in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery
 - .3 Visually inspect components and related sub-systems in presence of Consultant.
 - .4 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .5 Assess System and intersystem coordination
 - .6 Make modifications to work plan as necessary
- .2 Verification of existing conditions
 - .1 Verify location, use and status of material and equipment specified, indicated, or determined necessary for removal.
 - .1 Verify materials, equipment, and utilities to be removed are inactive, and not required or intended for use after completion of project.
 - .2 Replace with equivalent any material, equipment and utility removed by contractor that was required to be left in place.

- .2 Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner unless permitted under the following conditions and then only after arranging to provide temporary utility services, according to requirements indicated:
 - .1 Notify Owner in writing at least 14 days in advance of proposed utility interruptions.
 - .2 Do not proceed with utility interruptions without Owner's written permission.
- .3 Provide pull strings where empty conduit is installed.
- .4 Ensure continuity of existing services while completing the specified installation.
- .5 Arrange for any outages or interruptions in service one (1) week prior in writing with the Owner and notify affected stakeholders. Coordinate with Owner for any additional resources required during interruption in service.
- .6 Should services be interrupted accidentally, provide material and labour to re-establish services immediately and continue without stoppage until services have been re-established.
- .7 Cutting and Patching
 - .1 Perform cutting and patching according to contract general requirements and as follows:
 - .1 Remove and replace defective work.
 - .2 Remove and replace non-conforming work
 - .2 Cut, remove, and legally dispose of selected equipment, components, and materials, including removal of material, equipment, devices, and other items indicated to be removed and items made obsolete by new work.
 - .3 Provide and maintain temporary partitions or dust barriers adequate to prevent spread of dust and dirt to adjacent areas.
 - .4 Protect adjacent installations during work activities
 - .5 Protect structure, furnishings, finishes, and adjacent materials not to be removed
 - .6 Restoration of components using new materials specified for original installation and qualified subcontractors

7.2 INSTALLATION

- .1 Protect facility, equipment, and wiring from damage.
- .2 Install and configure systems in accordance with the manufacturer's instructions
- .3 Install wiring and cabling between equipment and related devices.
 - .1 Do not connect cabling to Owner's Ethernet switches. Owner's IT personnel only may authorize connection to Ethernet switches
- .4 Coordinate systems, equipment, and materials installation with other building components.
- .5 Install systems, materials, and equipment to conform to approved submittal data, including coordination drawings.

- .6 Conform to Contract Document arrangements indicated, recognizing that work may be shown in diagrammatic form or have been impracticable to detail items because of variances in manufacturers' methods of achieving specified results.
- .7 Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, whether installed in exposed or un-exposed spaces.
- .8 Install cabling, wiring, and equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum interference of adjacent other installations.
- .9 Provide access panel or doors where units are concealed behind finished surfaces.
- .10 Coordinate for risers, slots, and openings in other building components during construction, to allow for wiring, cabling, and equipment installations.
- .11 Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment in accordance with Prime Consultant's interior design sections and elevations
- .12 Avoid interference with structure and with work of other trades, preserving adequate headroom and clearance from obstructions, doors, and passageways to satisfaction of Owner and code requirements.
- .13 Install equipment and cabling to distribute equipment loads on building structural members provided; install and support suspensions evenly at 3-meter intervals and without concentrating loads
- .14 Provide supplementary or miscellaneous items, appurtenances, devices and materials for a complete installation
- .15 Install equipment in conveniently accessible locations for operation and maintenance. Remove and reinstall inaccessible equipment as directed and without extra cost.
- .16 Replace ceiling tiles as required to restore ceiling to uniformity and original condition
- .17 Restore walls, T-bar, paint, concrete surfaces, junction box covers as necessary to recreate original conditions
- .18 Replace missing junction or outlet box covers, firestopping material, bushings, screws, fasteners as necessary to provide systems as specified.
- .19 Restore weatherproofing to match existing where conduit or sleeve passes through building envelope to exterior. Reinstate weatherproof seal.
- .20 Locate equipment as close as practical to locations shown on drawings.
- .21 Note locations of equipment on record drawings.
- .22 Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment including equipment cabinets, without disassembly.

7.3 WIRING METHODS

- .1 Install cables in conduits or in cable tray as indicated; conceal cable and conduits.
- .2 Provide physical protection for installed cables.
- .3 J-hooks may be used under floor, or where cable tray is not provided

- .4 Horizontal cabling shall be supported by J-hooks every 4-feet once it leaves the cable tray.
- .5 Category cables for use in security systems such as CCTV shall be pulled through designated home-run conduit (by div. 26) from work area outlet to security cabinet in Hub room .
- .6 Install wiring to conform to the requirements of the Canadian Electrical Code, Part 1 and applicable Provincial Codes. Size wiring in accordance with Class 2 requirements; protect wiring against mechanical injury or other injurious conditions such as moisture, excessive heat or corrosive action in accordance with Class 1 requirements.
- .7 Use wire with copper conductors.
- .8 Copper termination hardware installation
 - .1 Cables shall be dressed and terminated in accordance with standards-based recommendations, the manufacturer's recommendations/installation guides, and industry best practices.
 - .2 Guide, position and secure twisted pairs at the connector termination point using a termination device that locks the pairs in place to prevent untwisting of pairs into the cable when terminating the conductors.
 - .3 The termination device holding the wires in place at the rear of the connector to withstand a tensile force of 15 lbs minimum applied to the cable without impacting the cable/connector continuity
 - .4 The connector termination method to involve no pair separation making bonded-pair cable quick and easy to terminate
 - .5 Install cables neatly bundled, dressed, and routed to their respective termination connectors. Each patch panel to terminate a cable bundle separated and dressed back to the point of cable entrance into the equipment cabinet or rack.
 - .6 Clearly label each cable on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support element(s). Labels obscured from view are not acceptable.

7.4 PROJECT MANAGEMENT

- .1 Obtain Safety, Environmental Report, Security, Parking, and credentialing information from Owner for conditions surrounding safety and access works on Owner's site.
- .2 Assign a project manager to serve as point of contact for Owner, contractor, and Consultant. This project manager is responsible for coordinating any work related to other divisions.
- .3 Be proactive in scheduling work.
 - .1 Use of premises is restricted to times directed by Owner.
 - .2 Movement of materials: Unload materials and equipment delivered to site. Pay costs for rigging, hoisting, lowering and moving equipment on and around site, in building or on roof.
 - .3 Coordinate installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - .4 Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of Work. Plan for large equipment requiring positioning prior to closing in building.

- .5 Coordinate connection of materials, equipment, and systems with exterior underground and overhead utilities and services. Comply with requirements of Owner, Governance, carriers, service providers, and legislation; provide required connection for each service.
- .6 Initiate and maintain discussion regarding schedule for ceiling construction and install cables to meet that schedule.
- .4 Communications Project Manager Responsibilities:
 - .1 Assume responsibility for overall telecommunications system integration and coordination of work among trades, subcontractors, and authorized system installers.
 - .2 Coordinate with related work indicated or specified.
 - .3 Manage work related to telecommunications system installation in a manner approved by manufacturer.

7.5 WORK IN EXISTING FACILITIES

- .1 Minimize disruption in active renovation areas and comply with Owner requirements. Coordinate with the Owner to create an efficient phasing plan so as to not disrupt a single area for an extended period of time.
- .2 Owner will have the final option for allowing the work to continue at the beginning of the day's work, if expected use is deemed critical for any specific day, Owner's staff can ask the contractor to work in another area until the expected peak usage diminishes
- .3 Develop a work plan for any renovations to be done in existing areas, whether operational or not, and submit work plan to the Owner for approval at least four (4) weeks prior to commencement of work. Revise the work plan as requested by the Owner to receive approval. Do not start work until the work plan has been approved. Include the following as a minimum:
 - .1 Phasing of work, itemize systems to be worked on or added and expected completion dates and times
 - .2 Room layout before and after to ensure proper clearances are being met.
 - .3 Rack elevations showing existing, interim and final placement of equipment.
 - .4 Areas affected by the work.
 - .5 Contractors responsible for the work.
 - .6 Any Owner staff or resources required.
 - .7 Hazardous materials or Designated Substances Engineering Controls or other protective measures required; hoarding and signage requirements
 - .8 Shut downs or interruptions in service, including anticipated and worst case timeframes, rollback procedures and systems affected.

7.6 CLEANING

- .1 Perform final cleaning in accordance with Division 01 documentation
- .2 Remove debris, rubbish, waste material, tools, construction equipment, machinery and surplus materials from project site and clean work area prior to final inspection and acceptance of work.

- .3 Place or restore building and premises into neat, clean condition.
- .4 Clean equipment and devices installed as part of this project.
- .5 Perform final cleaning after construction activities that create dust have been completed and prior to project acceptance by Owner's Representative.
- .6 Remove paint splatters and other spots, dirt, and debris; touch up any scratches to match original finish.
- .7 Clean devices internally using methods and materials recommended by manufacturer.
- .8 Perform final cleaning of telecommunications spaces:
 - .1 Thoroughly vacuum and clean interiors of panels, cabinets, racks and other equipment of construction debris and dust prior to installation of active equipment, using a HEPA vacuum cleaner. Final clean using clean lint free cloths with a cleaning liquid as recommended by the manufacturer for the purpose.
 - .2 HEPA vacuum the top, bottom and inside of cabinets, racks, cable trays, PDUs, IDC blocks and conduits, fire suppression equipment and mechanical duct work in the room, followed by a thorough HEPA vacuuming of the floors. Thoroughly wash floors with wet mop and clean water. Control access to the room after cleaning. Provide temporary filter media on air supply ducts to these rooms to prevent re-contamination from other areas of construction.

7.7 MILESTONE REVIEWS

- .1 Specific milestone reviews may be conducted at key stages by the Consultant, including;
 - .1 before backfilling of buried services,
 - .2 before closing of shafts,
 - .3 before closing of walls,
 - .4 before closing of ceilings,
 - .5 equipment demonstration,
 - .6 Substantial Performance deficiency review,
 - .7 Total Performance deficiency review.
- .2 Coordinate with the Consultant the type and quantity of milestone reviews required and incorporate these requirements into the construction schedule.
- .3 Prior to Work being concealed, notify the Consultant in writing seven (7) calendar days in advance of the planned concealment to arrange a site review, where required by the Consultant. Correct noted deficiencies before concealing the Work. Failure to provide notification can result in the Work being exposed for review at the Contractor's cost.

PART 8: TESTING & COMMISSIONING - See Division 27 08 00 for details

***** END OF SECTION *****

PART 1: GENERAL

1.1 SUMMARY

.1 Section Includes:

- .1 Commercial building cable trays for Communications.

1.2 REFERENCES:

- .1 ANSI/NFPA 70 – National Electrical Code (NEC)
- .2 Canadian Electrical Code (CEC)
- .3 ANSI/TIA-569C - Telecommunications Pathways & Spaces
- .4 ASTM A 510 - Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
- .5 ASTM A 380 – Specification for Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
- .6 ASTM B 633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- .7 ASTM A 123 – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- .8 ASTM A 653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
- .9 IEC 61537 (2001) – Cable Tray Systems and Cable Ladder Systems for Cable Management
- .10 NEMA VE 1-2002/CSA C22.2 No. 126.1-02 – Metal Cable Tray Systems

1.3 RELATED SECTIONS:

- .1 Section 01 00 00 – General Requirements
- .2 Section 27 05 26 – Grounding and Bonding for Communications Systems
- .3 Section 27 05 39 – Surface Raceway for Communications Systems
- .4 Section 27 05 53 – Identification for Communication Systems
- .5 Section 27 06 28 – Pathways for Communication Systems
- .6 Section 27 08 00 – Commissioning for Communications Systems
- .7 Section 27 11 16 – Communications Cabinets, Racks, Frames and Enclosures
- .8 Section 27 11 19 – Communications Termination Blocks and Patch Panels
- .9 Section 27 11 26 – Communications Rack Mounted Power Protections and Power Strips
- .10 Section 27 13 23 – Communications Fiber Backbone Cabling
- .11 Section 27 15 13 – Communications Copper Horizontal Cabling

.12 Section 27 15 43 – Communications Faceplates and Connectors

1.4 DEFINITIONS

- .1 Cable Raceway – Solid bottom rigid steel or aluminum raceway, with available solid lid. Comes in various sizes. Sometimes called “trunking”. This specification covers ONLY Wire-Mesh cable tray for Communications and does not cover solid bottom raceway.
- .2 Cable Tray – wire mesh basket tray, made of steel wire, welded and electro-tin coated and/or hot dip painted
- .3 Cable trays are defined to include straight sections, supports and accessories

1.5 OWNER FURNISHED

- .1 None. All equipment and installation noted in this specification is new.

1.6 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00, Submittal Procedures.
- .2 Action Submittals:
- .3 Shop Drawings for communications equipment room or floor area cable trays. Include plans, elevations, sections, details, and attachments to other work.
- .4 Submit shop drawings indicating materials, finish, dimensions, accessories, layout, supports, splices, and installation details.
- .5 Design Calculations: Verify loading capacities for supports.
- .6 Field verification of all dimensions, routing, etc., is directed.
- .7 Factory-certified test reports of specified products, complying with IEC 61537, NEC, and NEMA VE 1/CSA C22.2 No. 126.1.
- .8 Submit manufacturer's certification indicating ISO 9001 quality certified.
- .9 Submit training procedure for certifying cable tray installers

1.7 QUALITY ASSURANCE

- .1 Source Limitations: Obtain cable tray components through one source from a single manufacturer.
- .2 Approval and Labeling: Provide cable trays and accessories specified in this Section that are approved and labeled.
- .3 The Terms “Classified” pertaining to cable trays (rather than “Listed”) and “Labeled”:
- .4 “Nationally Recognized Testing Laboratory” such as UL, CUL and ETL.
- .5 Comply with NEMA VE 1/CSA C22.2 No. 126.1, Metal Cable Tray Systems, for materials, sizes, and configurations; provide cCSAus Certificate and labels.

1.8 COORDINATION

- .1 Coordinate layout and installation of cable tray with other trades.

- .2 Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Architect.
- .3 Storage and Handling: Avoid breakage, denting and scoring finishes. Damaged products will not be installed. Store cable trays and accessories in original cartons and in clean dry space; protect from weather and construction traffic. Wet materials will be unpacked and dried before storage

1.9 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, wood, corrugated cardboard packaging material in appropriate on site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal, wiring and plastic materials from landfill to metal/plastics recycling facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.
- .6 Dispose of unused paint material of at official hazardous material collections site approved by Departmental Representative.
- .7 Do not dispose of unused paint material into the sewer system, into streams, lakes, onto ground or in any other location where it will pose health or environmental hazard.

PART 2: PRODUCTS

2.1 MANUFACTURED COMPONENTS

- .1 Approved Manufacturers
- .2 Legrand Cablofil
- .3 Copper B-Line Flextray
- .4 nVent WBT
- .5 Chatsworth Products Inc. (Pemsa Rejiband)

2.2 MATERIALS AND FINISHES:

- .1 Cable Tray Materials:
- .2 Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent, and surface treated after manufacture.
- .3 Cable Tray Finishes:
- .4 Finish for Carbon Steel Wire after welding and bending of mesh;
- .5 Electrodeposited Zinc Plating: ASTM B 633, Type III, SC-1.
- .6 Cable tray will consist of continuous, rigid, welded steel wire mesh cable management system, to allow continuous ventilation of cables and maximum dissipation of heat, with UL Classified splices where tray (including UL Classified painted tray) acts as Equipment Grounding Conductor (EGC).

- .7 Provide splices, supports, and other fittings necessary for a complete, continuously grounded system.
- .8 Mesh: 4 x 12 inches (100 x 300 mm)
- .9 Straight Section Lengths: 118 inches (3,000 mm).
- .10 Wire Diameter: minimum 5mm.
- .11 Fittings: Wire mesh cable tray fittings are field-fabricated from straight tray sections, in accordance with manufacturer's instructions.
- .12 Cable Tray Supports & Accessories
- .13 Fittings/Supports: Wire mesh cable tray fittings are field-fabricated from straight tray sections, in accordance with manufacturer's instructions. Place supports so that support span does not exceed 5 ft.
- .14 System support methods to mount from ceiling and wall structures with 1/4", 3/8" or 1/2" threaded rod, if applicable
- .15 Splices, including those approved for electrical continuity (bonding), as recommended by cable tray manufacturer.
- .16 Grounding and bonding – Follow ANSI/TIA 607D, ensuring bonding continuity of wire mesh tray sections to earthing system. Bond to PBB/SBB with a minimum #6 AWG Grounding Bonding conductor.

PART 3: EXECUTION

3.1 EXAMINATION

- .1 Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of cable trays. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION.

- .1 Install cable tray level and plumb according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
- .2 Cutting: Field-fabricate changes in direction & elevation by cutting & bending cable tray.
- .3 Cut cable tray wires in accordance with manufacturer's instructions.
- .4 Cable tray wires must be cut with side-action bolt cutters with offset head to ensure integrity of protective galvanic layer.
- .5 Remove burrs and sharp edges from cable trays.

3.3 IDENTIFICATION AND ADMINISTRATION

- .1 Provide labeling according to the requirements of:
- .2 ANSI/TIA/EIA-606D.

END OF SECTION

PART 1: GENERAL

1.1 SUMMARY

- .1 Identification for Communications Systems
- .2 The Contractor shall supply a labelling standard based on the City of Toronto – Commercial Facilities Structured Cabling Systems Design Guide for Consulting Engineers, Architects, Designers & Contractors - Revision 1.0, January 2023 which have been referenced below. The contractor shall confirm final labelling requirements with City of Toronto IT prior to deployment. All labelling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labelling scheme.

1.2 SUBMITTALS

- .1 Product Data
 - .1 Labelling software shall be easily useable and run on Microsoft Windows® operating systems. Labelling software shall be compliant with TIA/EIA-606-D and shall be able to produce complex unique identifiers of up to 12 independent segments. Labelling software shall be capable of inserting symbols as well as use any standard True Type Font as well as capable of saving individual build information and of fine tuning print adjustments.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, wood, corrugated cardboard packaging material in appropriate on site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal, wiring and plastic materials from landfill to metal/plastics recycling facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.
- .6 Dispose of unused paint material at official hazardous material collections site approved by Departmental Representative.
- .7 Do not dispose of unused paint material into the sewer system, into streams, lakes, onto ground or in any other location where it will pose health or environmental hazard.

PART 2: PRODUCTS

2.1 OWNER FURNISHED

- .1 The labelling standard below is taken directly from Appendix A - City of Toronto – Commercial Facilities Structured Cabling Systems Design Guide for Consulting Engineers, Architects, Designers & Contractors - Revision 1.0, January 2023
- .2 Design Guide of Tagging Convention (Identification and Labeling)
 - .1 The requirements of this section shall take precedence over other sections
 - .2 The labeling of the City of Toronto network components, structured cabling and cable routing/containment shall comply with the ANSI/TIA-606 standard.
 - .3 The codification of network components, cables and cable routing shall follow the identification standards detailed in this standard.
 - For example:

- Building Location: YDE – 30 Dee Ave
- Floor and Room Location: ER – Equipment Room / Server Room / Main Communications Room
 - TRA – Telecom Room - A
 - TRB – Telecom Room – B
 - EF - Entrance Facility
- Service Provider / Network Cabinet Label in ER: COT-IT-YDE-0100 Network Closet
- Network Cabinet Label in ER: COT-IT-YDE-0200 Network Closet
- Server Cabinet Label in ER: COT-IT-YDE-0300 Server Closet
- Patch Panel:
 - A – Data Patch Panel A (A,B,C, etc ...)
 - FP01 – Fibre Optic Patch Panel
 - TP01 – Telephone/Voice Patch Panel
- Patch Panel Port:
 - 01 – Patch Panel Port (01, 02, 03, ..., 24)
- Work Area Number:
 - 125 – Work Area number associated in the admin/office areas of the facility
- Work Area Outlet:
 - WA01 – Work area outlet (01, 02, 03, etc...),
 - 1 – Port number (1, 2, 3, 4)

.3 Equipment / Network / Server Room Cabinets Identification and Labeling

- Equipment Room/Server Room network enclosure contains active network components, including: Network Core Closet, Server Closet and Telecommunications Enclosure. All Network Closets/Cabinets related to the Equipment Room (ER) shall be tagged as follows.
- COT-IT-XYZ-XX00, where:
 - XYZ = Site three-character code name
 - XX00 = First two numbers (XX) identify the closet
- For all closets/enclosures/cabinets in the Equipment Room, the last two numbers are always zero (00).
- For Closets/Cabinets in the Equipment Room, they are numbered from (0100) to (1000).
- Network Core Closet and Server Closet nameplate shall conform as follows:
 - Provide nameplate for each enclosure on the bottom-center of the door, front and back.
 - Use engraved gravoply laminate nameplates using black letters on a white background.
 - The laminate nameplates shall have a dimension of 210mm W x 50mm H.
 - Minimum character height shall be 12mm. Character lettering shall be centered on each line.
 - Mount nameplates with two stainless steel machine screws.
 - Include device identification (tag) number as well as a descriptive name.
 - For example: the tag name: COT-IT-XYZ-0100 followed by the description i.e. "NETWORK CLOSET"

.4 Copper Patch Panel (CP) & Work Area Outlet (WA) Identification and Labeling

- The copper data patch panels in a Telecommunications Enclosure/Closet shall employ one
- character A, B, C, ..., Z. The rack shall be populated with patch panel(s) as necessary and
- labeled in sequential order from top to bottom.
- For example, the first copper data patch panel from the top of the rack shall be labeled A, the
- second shall be B, and so on.
- Each 24-port patch panel shall have six (6) snap-in faceplates that group four terminations.
- For
- office areas, the minimum number of ports associated with a work area outlet shall be a
- group
- of two (2) ports.
- Labels shall be applied to patch panels in such a manner as to be readily visible and not
- obscured by structured cabling or patch cords.
- Labels for each 4-port or 2-port, snap-in faceplate shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels shall not be accepted.

- Lettering shall be black on a white background. Characters are a minimum of 4mm high. Apply a label on the top of each group of 4-ports or 2-ports on the snap-in faceplate to indicate the destination of the cables terminated on the data ports (RJ).
- For office areas, the label 125-WA01 would be applied on the patch panel for a group of 2 ports with destination cables to work area outlet 125-WA01. Whereas, 125 represents the room number of the facility and WA01 represents the work area 01.
- Apply a two-digit label immediately above each data port (RJ) indicating its destination port number on the work area outlet. For example, a group of four consecutive ports on a 24-port patch panel whose destination is port numbers 1 to 4 on a WAO would have the ports labeled 1, 2, 3, 4. Provide color-coded, snap-in icons for each data port (RJ).

.5 Fibreoptics Patch Panel (FPP) Identification and Labeling

- Lettering shall be black on a white background. Characters are a minimum of 4mm high.
- Terminate all 12 fibres of each fibre optic cable in Fibre Enclosures (Telecommunications Enclosure or Network Core Closet).
- The fibre cable for all even-numbered Telecommunications Enclosures shall terminate at Network Core Closet 02 (XYZ-0200) while odd-numbered shall terminate at Network Core Closet 01 (XYZ-0100).
 - For cases where Network Core Closet 01 and Network Core Closet 02 are located in different Equipment Rooms, Telecommunications Rooms / Telecommunications Enclosures shall have fibre terminating in both Network Core Closets.
- The ordering and color of individual fibres shall be the same for each fibre cable and compliant with the latest ANSI/TIA-568.3 and ANSI/TIA-598 standards.
- Labels for patch panels shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels shall not be accepted.
- Labels shall be applied to patch panels in such a manner as to be readily visible and not obscured by structured cabling or patch cords.
- A label shall be applied to the top of the LC duplex adapter modules associated with a single fibre cable indicating the destination of the cable.
 - For example, the adapter modules that terminate the fibre cable whose destination is Telecommunications Enclosure 1400 would be labeled as XYZ-1400.
- The fibre patch panel label shall be labeled as follows FPXX where XX is the fibre patch panel sequence i.e. 01, 02, 03...etc. The rack shall be populated with patch panels as necessary and labeled in sequential order from top to bottom.
 - For example, the first patch panel from the top of the rack would be labeled as FP01, the second is FP02 and so on.

.6 Work Area Outlet (WAO) Identification and Labeling

- Labels for each 4-port, work area outlet shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels shall not be accepted.
- Lettering shall be black on a white background. Characters shall be a minimum of 4mm high.
- A label shall be applied to the top of each 4-port, work-area outlet indicating the source of the Horizontal cables.
- For example, WAO port 1 connected to patch panel A port 1 would be labelled as A01. WAO port 2 to patch panel A port 2 is labelled A02 and so on.

.7 Cable Identification and Labeling

- Use durable non-fading sleeve type wire markers to identify all network cables. Labels for cabling shall be laser printed, self-laminating, adhesive, polyester (indoor/outdoor). Hand-written labels will not be accepted.
- Lettering shall be black on a white background. Characters shall be a minimum of 4mm in height.

.8 Fibreoptics Backbone Cable Identification and Labeling

- As a minimum, all fibre optic backbone cables shall be labeled at both ends of the cable, within every pull box and every 15 metres.
- In addition, the fibre backbone cables shall be labeled at each transition. A transition is defined as: a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
- If the fibre cable is run in conduit then the transition labels shall be applied to the conduit.
- The tagging convention for identification of fibre optic backbone cables shall indicate the

source and destination of the cable separated by a colon.

- For example, a fibre optic backbone cable whose source is Network Core Closet 2 (XYZ-0200), Fibre Patch Panel 01, adapter panel A and terminates in Telecommunications Enclosure 1400 (XYZ-1400) on the fibre patch panel 01 adapter panel A would have the following tag: 0200-FP01-A.01: 1400-FP01-A.01. The last "01" digits represent fibre strands.
- The Telecommunications Enclosure fibre optic patch panel must be labeled.
 - For example: Telecommunication Enclosure 1400 with two fibre optic patch panels would be labeled "FP01" and "FP02", where "FP01" is the first patch panel from the top.

.9 Horizontal Copper Cable Identification and Labeling

- As a minimum, all horizontal CAT6/CAT6A cables shall be labeled at both ends of the cable, within every pull box and every 15 metres.
- In addition, the cables shall be labeled at each transition. A transition is defined as: a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
- If the cable is run in conduit then the transition labels shall be applied to the conduit.
- The tagging convention for identification of Horizontal cables shall indicate the source and destination of the cable separated by a colon.
 - Example 1: a horizontal cable whose source is Telecommunications Enclosure TRB-4, Patch Panel A, port 01 and whose destination is port 1, Work-Area Outlet 01, in room number 125 would have the following tag: YDE-TRB-4-A01:125-WA01-1.

.10 Voice Backbone Copper Cable Identification and Labeling

- As a minimum, all voice backbone cables shall be labeled at both ends of the cable, within every pull box and every 15 metres.
- In addition, the voice backbone cables shall be labeled at each transition. A transition is defined as - a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor. If the voice cable is run in conduit then the transition labels shall be applied to the conduit.
- The tagging convention for identification of voice cables between the voice block and the Telecom Closet/Enclosure patch panel in the building shall be VFFA-CC : XYZ-A-TP01 (indicate the source and destination of the cable separated by a colon), where V indicates voice, FF indicates the floor number, EF indicates telecommunications entrance facility ID, CC indicates 2-digit voice cable number, and XYZ-A is telecommunications closet/enclosure ID.
 - For example, voice cable 01 whose source is entrance room EF and terminates in Telecommunications Room B (YDE-TRB) on patch panel TP01 would have the following tag: V01EF-01 : YDE-TRB-TP01.

.11 Patch Cord Identification and Labeling

- As a minimum, all Contractor installed CAT6/CAT6A or fibre optic patch cords shall be labeled at both ends of the cable.
- The tagging convention for identification of patch cords shall indicate the source and destination of the cable separated by a colon. The source is the switch port and the destination is the patch panel, termination point.

.12 Cable Pathways Identification and Labeling

- All ducting (cable tray or conduit) carrying fibre optic and multi-pair voice backbone cables shall be tagged as "LAN BACKBONE ".
- All ducting (cable tray or conduit) carrying Horizontal cables shall be tagged as "LAN HORIZONTAL" with the source and destination network panels.
- All ducting shall be labeled at each transition. A transition is defined as - a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
- Use engraved Gravoply laminate nameplates using black letters on white background.
- The laminate nameplates shall have a dimension of 210mm W x 50mm H.
- Minimum character height shall be 12mm. Character lettering shall be centered on each line.

2.2 MANUFACTURED COMPONENTS

- .1 Faceplate labels for faceplates at each work station shall be white perforated card stock compatible with inkjet and laser printers or pre-cut self-adhesive polyester compatible with inkjet or laser printers. Labels shall be 1.98" x 0.373" in size and be divided 72 labels per sheet with each sheet being 8.5" x 11". Labels may also be printed on polyester roll stock for a suitable TIA-606D Standards compliant handheld labeler. Printed labels are a minimum of 10 pt, sans-serif font.
- .2 Patch Panel labels shall be white pre-cut self-adhesive polyester. Labels shall be [3.10" x 0.50" (for patch panels without icons) or 3.30" x 0.25" (for patch panels with icons)] in size and be divided [36 or 72] labels per sheet with each sheet being 8.5" x 11". Labels may also be printed on polyester roll stock for a suitable TIA-606D Standards compliant handheld labeler. Printed labels are a minimum of 10 pt, sans-serif font.
- .3 Cross-connect labels shall be perforated card stock compatible with inkjet and laser printers or pre-cut self-adhesive polyester compatible with laser printers and be colour coded per the labelling scheme for card stock. Labels shall be 7.90" x 0.48" in size and be divided 18 labels per sheet with each sheet being 8.5" x 11". Printed labels are a minimum of 10 pt, sans-serif font.
- .4 Cable labels shall be self-adhesive, self-laminating, pre-cut and laser-printer compatible. Labels shall be used with 4-pair horizontal unshielded/shielded twisted pair cable and for fiber optic cable, and/or 25-Pair backbone cables, be 0.984" x 1.496" (4-Pair) and/or 0.984" x 2.480" (25-Pair) in size and be divided 48 (4-Pair) and/or 24 (25-Pair) labels per sheet with each sheet being 8.5" x 11". Printed labels are a minimum of 10 pt, sans-serif font.

PART 3: EXECUTION

3.1 PREPARATION

- .1 The labelling shall be machine-generated and affixed to the cable, faceplate, patch panel, rack or other hardware.
- .2 Labelling must match the cable run-sheets and cable certification tester conformance documentation, for both copper and optical fibre components.

3.2 INSTALLATION

- .1 Install all systems in accordance with manufacturer's printed instructions, as well as ANSI/EIA/TIA 606-D – "Administration Standard for Commercial Telecommunications Infrastructure".
- .2 Labels shall be affixed in a level and square position.
- .3 Install labels in such a way as to be physically and visually accessible.
- .4 Remove any temporary labels and ensure no permanent labels are damaged during construction.
- .5 Replace all damaged or missing permanent labels prior to substantial completion.
- .6 Cable Labelling
 - .1 All cabling runs shall be labelled in four (4) locations including at each end of the cable, on the corresponding faceplate and patch panel or IDC mount.
- .7 Patch Cord Labelling
 - .1 Each patch cord shall be labelled with one label at each end.

- .8 Rack and Cabinet Labelling
 - .1 Each rack and cabinet shall be labelled with one label on the front (top) and one label on the back (top).
- .9 Active Equipment Labelling
 - .1 Each piece of active equipment, such as switches, routers, local ups, etc. shall be labelled with one label on the front and one label on the back.

3.3 PATHWAYS

- .1 Conduit
 - .1 Label exterior of conduit as COMMUNICATIONS (unless otherwise noted on the drawings) with text readable from a standing position on the finished floor.
 - .2 For wall stub-up locations, label overhead only.
 - .3 For strictly overhead conduits, label both ends.
 - .4 For long runs of conduits that stub directly up or into Communications Room, label the end of the conduit in the Communications Room with the destination room number or location..
 - .5 Sleeves which pass through a single wall or floor need not be labeled.
- .2 Junction boxes and pull boxes
 - .1 Label exterior of junction boxes and pull boxes as COMMUNICATIONS with text readable from a standing position on the finished floor.
- .3 Firestop locations
 - .1 All communications firestop locations are to be labeled on both sides of wall or floor. Refer to firestopping specification section for additional information.
- .4 Grounding
 - .1 Label PBB as FLOOR# - ROOM# - PBB.
 - .2 Label SBB's as FLOOR# - ROOM# - SBB.
 - .3 Label grounding conductors within 12" of both ends with Warning Marker and Identification Label.
 - .1 Identification label is to include the source and destination of the grounding conductor.

***** END OF SECTION *****

PART 1: GENERAL

1.1 INCLUDED SYSTEMS AND EQUIPMENT

- .1 The following is a list of the equipment and system test requirements that will need to be included in this section.

1.2 DESCRIPTION

- .1 The purpose of this section is to specify Division 27 responsibilities in the commissioning process which are being directed by the Commissioning Authority (CA).
- .2 Commissioning requires the participation of Division 27 to ensure that all systems are operating in a manner consistent with the Contract Documents.

1.3 RESPONSIBILITIES

- .1 Communication Contractor. The commissioning responsibilities applicable to the Communication Contractor are as follows (all references apply to commissioned equipment only):
 - .1 Documentation of all procedures performed shall be provided and forwarded to the Communications Designer. Written documentation must contain recorded test values of all electrical tests performed per the individual product specification.
 - .2 The start-up service company shall be present during energization of the Communication equipment. Jobsite and equipment access must be provided by the General Contractor during regular business hours
 - .3 The contractor shall supply a power source, specified by the start-up service company, for on-site test equipment.
 - .4 Perform tests using qualified personnel. Provide necessary instruments and equipment.
 - .5 Include the cost of commissioning in the contract price, if not yet let.
 - .6 Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the CA for review.
 - .7 Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 - .8 Perform and clearly document all completed system operational checkout procedures, providing a copy to the CA.
 - .9 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
 - .10 Perform functional performance testing under the direction of the CA for specified equipment in Section 27. Assist the CA in interpreting the monitoring data, as necessary.
 - .11 Correct deficiencies (differences between specified and observed performance) as interpreted by the CA, PM/GC and Communications Engineer and retest the equipment.
 - .12 During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings and final as-builts

for contractor-generated coordination drawings.

- .13 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
- .14 Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

PART 2: EXECUTION

2.1 SUBMITTALS

- .1 Division 27 shall provide submittal documentation relative to commissioning to the CA as requested by the CA. Refer to Section 01 91 00 for additional Division 27 requirements.

2.2 TESTING OF CABLES

- .1 All cables to be tested after complete installation from termination end to termination end under worst-case environmental conditions and in accordance with this and the manufacturer's specification.
- .2 Testing of all copper media will include verification of labelling integrity, d.c., continuity of each conductor, correct pair polarity termination, shorts between conductors, shorts between conductors and shield, length and the proper operation of shorting bars where provided.
- .3 Testing of 75 Ohm copper coaxial cables shall be as per TIA/EIA 568.4-D-2017, *Broadband Coaxial Cabling and Components Standard*.
- .4 Testing of 50 Ohm RF coaxial cables shall be done with the coaxial cable adapter on the certification tester. If the cables are terminated in BNC or NC connectors, use a BNC/NC to F adapter for the cable test. Record continuity, DC resistance, Velocity of propagation, impedance, capacitance and attenuation values at multiple frequencies, including the maximum frequency in use on that particular link. Compare the values with the manufacturer's documentation and record in test results.
- .5 The Contractor shall also test all four (4) pair Communications data and voice UTP cabling runs to full compliance of TIA/EIA 568.2-D-2018 performance parameters including but not limited to the following parameters: wire map, insertion loss (attenuation), noise, DC loop resistance, DC resistance Unbalance within a pair, DC Unbalance resistance between pairs, PSNEXT, ELFEXT, PS ELFEXT, ACR, PS ACR, Delay Skew, Propagation Delay and Signal Loss measurements for Category 6A (data and voice) compliance in accordance to TIA/EIA 568.2.-D-2018. Full bandwidth, graphical results of all tests must be provided for all cables. Category 6A testing to include Alien Crosstalk (ANEXT and AFEXT) to 500 MHz.
- .6 Alien Cross talk testing to satisfy Category 6A shall be tested according to the Sampling Plan outlined in ISO/IEC 14763-2. There shall be an equal selection of short, medium and long length links in the sample plan.
- .7 All installed cables and terminations must meet or exceed the minimum specifications of the manufacturer. All four (4) pair UTP cables must fully pass minimum of TIA/EIA Category 6A **Permanent Link** performance specifications. Marginal or conditional passes are NOT acceptable and must be corrected prior to test result submission. Any cables or terminations failing to meet these specifications to be promptly replaced or repaired by the Contractor at no additional cost. The Owner and/or Engineer reserve the right to determine whether such product should be replaced or repaired. Such products to be replaced when requested by the Owner and/or Engineer.
- .8 The tester and procedures for the testing of copper twisted cables shall be as defined in ANSI/TIA-1152A. A minimum Level IV calibrated tester will be used for the tests.
 - .1 Acceptable Testers are:

- .1 Fluke Versiv DSX-5000 series, with copper, optical fibre and coaxial cable adapters
 - .2 Ideal Networks Lantek IV series, with copper, optical fibre and coaxial cable adapters
 - .3 WireExpert 4500, by Softing, with copper, optical fibre and coaxial cable adapters
- .9 Tabulation and Documentation of all test results and cable characteristics.
- .1 All testing and repairing must be completed and approved at least (30) thirty days prior to the handover of the project.
 - .2 Provide adequate personnel for immediate on-site problem determination, these staff must be available onsite for support five (5) days post-handover.
 - .3 All defects and deficiencies which originate or become evident during the warranty period to be repaired or replaced without additional expense to the Owner within 24 hours (1 day). All such work must be performed at a time which is acceptable to the Owner which may be outside regular working hours.
 - .4 Provide in soft copy format on media stick, tabulated results for every communication cable (copper/fiber/coaxial). The soft copy to be supplied with the test equipment manufacturer's software required to view the test results including viewing of all full bandwidth graphical data.
 - .5 Additionally, the contractor shall provide a cable test summary report indicating when the cable was tested, the result (pass or fail), the length of the cable, and the minimum headroom over TIA/EIA Category 6A standards. This test summary to be signed by an authorized cabling contractor personnel/manager.
 - .6 All test equipment used must have been calibrated at the manufacturer within twelve (12) months of test performed. Proof of calibration to be provided either by manufacturer certificate or a picture of the test equipment calibration field.
 - .7 All cable test results/reports must be submitted to The Hidi Group for review two (2) weeks prior to handover of project.
 - .8 Submit complete test results and formal written certification that the Communications Cabling System is installed and operating in accordance with this and the manufacturers' specifications.
 - .9 Contractor to provide manufacturer's preliminary certification number within 10 days of contract award.

2.3 WRITTEN WORK PRODUCTS

- .1 Contractor to provide a letter of certification within 2 weeks of substantial completion. This letter shall include: notification of 10Gig or Augmented Category 6 installation, verification of performance of the installed system, manufacturers certification number, identification of installation by location and project number and a copy of the warranty certification request form. The system must meet or exceed a minimum 20 Year warranty offered by the main structured wiring manufacturer. The contractor must follow the process from start to finish and document all steps to meet the warranty as outlined by the manufacturer. The acceptable manufacturer warranties are listed on page 1 of 4 in section 27 15 13. (MANUFACTURED COMPONENTS)

***** END OF SECTION *****

PART 1: GENERAL

1.1 SUMMARY

.1 Communications Cabinets, Racks, Frames, Enclosures

- .1 The Telecommunication Rooms (TR) shall house racks, cabinets, voice termination fields, and required cable routing hardware. Racks and cabinets shall be placed in a manner that will allow a minimum of 3 feet of clearance from the front and rear mounting surfaces and on one side. If one mounting rail of the rack is placed against a wall, the mounting rail shall be no closer than 6" to the wall to allow room for vertical management. Where there is more than one rack or cabinet, the racks or cabinets shall be ganged with vertical management hardware to provide inter-bay management. Ganged rack/cabinet frames will be placed in a manner that will allow a minimum of 3 feet of clearance from the front and rear mounting surfaces and on one side of the ganged assembly. In all telecommunication rooms the racks/cabinets shall be on the opposite side of the room from the voice termination fields.

1.2 SUBMITTALS

.1 Product Data

- .1 All equipment racks and cabinets shall be augmented with horizontal and vertical cable management hardware, both front and rear, to properly dress horizontal cables and patch cords. See drawings for cabinet and rack elevation positions of equipment.
- .2 The HIDI Group makes reference to product names as follows:
 - .1 "Racks" – open frame 2 post or 4 post support structures for telecommunications and power distribution devices. Racks usually have few configuration options beyond size and vertical cable managers. Refer to the drawings and part numbers for the accessories and configurations required.
 - .2 "Cabinets" – enclosed 4 post frames equipped with side walls, front and rear doors and top/bottom panels and heat management devices. Cabinets often have multiple configuration options. Refer to the drawings and part numbers for the accessories and configurations required.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, wood, corrugated cardboard packaging material in appropriate on site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal, wiring and plastic materials from landfill to metal/plastics recycling facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.
- .6 Dispose of unused paint material of at official hazardous material collections site approved by Departmental Representative.

- .7 Do not dispose of unused paint material into the sewer system, into streams, lakes, onto ground or in any other location where it will pose health or environmental hazard.

PART 2: PRODUCTS

2.1 OWNER FURNISHED

- .1 Contractor to provide all equipment as per drawings.

2.2 MANUFACTURED COMPONENTS

.1 Communications Racks/Cabinets

- .1 City of Toronto Corporate Security Specified Product: 25RU Tripp-Lite SmartRack Model#SR25UB complete with Roof-Mounted Fan Panel Model#SRFANROOF for Server Room Security Equipment.
- .2 See drawings for cabinet and rack design intent.
- .3 Ensure that power distribution components such as UPS units, PDUs and surge suppressors fit properly into the racks/cabinets so that all doors can close with power supply cables and communications patch cables installed, without pinching. Ensure that PDUs selected match the height or depth of the rack/cabinet.
- .1 Locate racks/cabinets as shown on the drawings; anchor racks/wall cabinets securely to the floor/wall. Floor mount racks and cabinets will be anchored with four (4) bolts each. Bolts/anchors used to mount must be made flush and any sharp edges must be removed. Mount equipment in racks/cabinets as shown on detail sketches.
- .2 Ensure lighting is available to provide 300 Lux illumination to the front and rear of all racks and cabinets, in open and closed positions. Coordination with the Electrical Engineers is required.
- .3 Casters should be used for placement of equipment; if casters cannot be concealed when raised they must be removed in order to provide a flush mounting surface for the cabinets.
- .4 Ground racks, patch panels, cabinets, voice cables, metal raceways and data equipment to building ground busbars using minimum #6 AWG insulated ground wire. Main grounding system including room serving ground busbars will be designed and installed under the electrical scope of work.
- .5 All racks must be connected to the telecommunications grounding bus bar as defined in the grounding section.
- .6 Ground cable shall be insulated green jacket, braided copper wire installed in each communication room that connects to the building ground system. Minimum wire size shall be #6 AWG for Telecommunications closets and #1/0 for main building communications room.
- .7 Grounding system for main building communications room shall be designed such that the individual grounding runs to each piece of equipment does not exceed 5' from the main loop.
- .8 Grounding to tie into a single ground point only.

- .9 Daisy chain of # 6 gauge wire between cabinets will not be accepted.
- .10 In all cases racks and components are to be black in colour.
- .4 Rack requirements:
 - .1 Refer to drawings for locations and quantities.
 - .2 Full Size 2-Post Racks must be 7-foot, 45U and have threaded holes for 10/32 screws. No cage nuts.
- .5 Vertical cable managers
 - .1 Contractor shall supply and install cable managers as per the drawings.
 - .2 The vertical cable managers shall have the following characteristics:
 - .3 Suitable for use with any EIA Compliant 45U rack.
 - .4 Vertical cable managers shall be metal with a hinged cover.
- .6 Finishes:
 - .1 Racks/Cabinets, Horizontal and Vertical management shall be black in color, electro-powder coat.

PART 3: EXECUTION

3.1 INSTALLATION

- .1 Install all systems in accordance with manufacturer's printed instructions and manufacturer suggested best practices.
- .2 All cabinets must be connected to the Telecommunications Primary Busbar (PBB) or Telecommunication Secondary Busbar (SBB) as defined in the grounding section.
- .3 Locate cabinets as shown on contract drawing, anchor cabinets securely to the floor. Bolts/anchors used to mount must be made flush and any sharp edges must be removed. Mount equipment in cabinets as shown on detail sketches.
- .4 Ensure cabinet is mounted in a way in which all doors are free from impediment and to ensure that ease of execution of work is considered.

***** END OF SECTION *****

PART 1: GENERAL**1.1 SUMMARY**

- .1 Communications Termination Blocks and Patch Panels
- .2 Termination block fields shall be mounted on 4' x 8' x .75" fire retardant plywood, unless otherwise noted in drawings. Patch panels for fiber and copper terminations will be housed in racks, cabinets, wall cabinets and other types of communication enclosures. The Contractor shall provide innerduct for all backbone fiber runs within telecommunication rooms. Industry approved J-Hook style cable supports must be used for added support where required by the standards as outlined by the TIA/EIA and other local CEC/ESA requirements.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, wood, corrugated cardboard packaging material in appropriate on site bins for recycling in accordance with the Waste Management Plan.
- .4 Divert unused metal, wiring and plastic materials from landfill to metal/plastics recycling facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.
- .6 Dispose of unused paint material of at official hazardous material collections site approved by Departmental Representative.
 - .1 Do not dispose of unused paint material into the sewer system, into streams, lakes, onto ground or in any other location where it will pose health or environmental hazard.

PART 2: PRODUCTS**2.1 OWNER FURNISHED**

- .1 All products are new and supplied by contractor.

2.2 MANUFACTURED COMPONENTS

- .1 Acceptable Manufacturer: Belden.
- .2 The contractor will provide submittals and cut sheets for all products that they are proposing.
- .3 The contractor must issue at time of project completion a manufacturers certified solution certificate from one of the following manufacturers:
 - .1 Termination Hardware - Copper Backbone
 - .1 The copper backbone cable will be terminated on BIX termination blocks and run back to a dedicated patch panel within the IT rack within all Telecommunications Rooms (TR) as noted on the drawings. Include D-rings between each field.
 - .2 The contractor will provide all necessary x-connects between fields where required.

- .3 Designation Strips labels must be used to identify cable pair counts, colour coded and label standards as per the TIA/EIA 606 standards. Samples of all labeling schemes and label types must be provided to owner before implementation.
- .4 Refer to drawings for a typical Voice Backboard layout and/or detail.
- .4 Horizontal Copper Cabling termination modules, Voice and Data Cat 6, and Security Cat6A
 - .1 All UTP modules shall be Category 6A Modules and shall follow performance parameters as outlined in ANSI/TIA 568.2-D.
 - .2 Cover plates
 - .1 Division 26 (Electrical) shall supply and install all communication outlet boxes. Faceplates will be supplied by ELV contractor. These are to match electrical specifications for cover plate style and colour. Communication contractor is responsible for the module mounting strap, colors to be determined by Owner.
 - .2 Hub Room terminations - Horizontal Voice and Data Cables
 - .1 Some voice cables will terminate using BIX termination products. See drawings for details.
 - .2 All data cables and voice cables shall terminate on 24 or 48 port modular patch panels, 1 RU high for 24 port and 2RU high for 48 port, rack mount (No 1RU 48 port high density 6A panels will be accepted). See drawings for details. They shall have the following minimum parameters:
 - .3 Physical Characteristics:

1U Panel:	45 x 483 x 13 mm (1.75" x 19" x 0.5")
2U Panel:	90 x 483 x 13 mm (3.5" x 19" x 0.5")
 - .4 Materials:

Panel:	Steel, 16 gauge, powder paint finish, black
Modular Holder:	Fire retardant plastic, UL94V-0
 - .5 These shall be placed on the front of the cabinets/racks. Refer to drawings for quantities of panels and modules.
 - .6 All patching and cross connects will be done by the Communications Contractor
- .5 Termination Hardware – 75 Ohm Coaxial Cables for Cable TV, horizontal station cables
 - .1 Copper coaxial cables shall be terminated on 75 Ohm rack or bulkhead products using F precision 75 ohm connectors. All connectors in bulkheads or faceplates are female. 75 Ohm patch cords are male to male.
 - .2 F connectors must be sized for the size and type of cable. An RG-6U sized connector must be used on an RG-6U cable, for example. Plenum cables often have different diameters than non-plenum cables. Use the Connector size that matches the cable type.
 - .3 Connectors must be mechanically compressed onto the cable using the appropriate die for the

size of the cable, as per the manufacturer instructions. Soldered connectors are not acceptable.

- .4
- Return loss performance of installed 75 Ohm connectors shall be equal to or better than -20dB at 4.5GHz.
- .5
- All runs of coaxial cable are to be terminated at the work area outlet location indicated on the drawings, with a minimum of 25-feet of slack neatly coiled and secured at the plywood backboard closest to racks within the Hub room.

PART 3: EXECUTION

3.1 INSTALLATION

- .1
- Install all systems in accordance with manufacturer's printed instructions and manufacturer suggested best practices.
- .1
- The horizontal data cables will be contained in cabinets, racks and other types of enclosures. All equipment racks shall be augmented with horizontal and vertical cable management hardware, both front and rear, to properly dress horizontal cables and patch cords.
- .2
- All voice terminations will be done on plywood backboards and brought to a 24-port patch panel in the rack via six (6) category 6A cables. See drawings.

***** END OF SECTION *****

PART 1: GENERAL

1.1 SUMMARY

- .1 The power cord must be a minimum 8 feet in length to reach up to the cable-tray or down to the floor where it will plug into a receptacle (supplied by Division 26).
- .2 The power bar(s) shall be UL/ULC listed and shall meet UL/ULC 1363 and 1449 requirements.

PART 2: PRODUCTS

2.1 OWNER FURNISHED

- .1 All products are new by Contractor.

2.2 MANUFACTURED COMPONENTS

- .1 Vertical Power Bars.
 - .1 Each equipment rack located in the Hub Room shall come complete with one (1) vertical power bar.
 - .2 The power bars shall be UL/ULC listed and shall meet UL/ULC 1363 and 1449 requirements.
 - .3 Specified Product for 2-post IT racks: Cabletalk CTPBV-1277-ST-B
 - .4 Specified Product for Security Cabinet: Tripp-Lite PS2408B
- .2 Uninterruptible Power Supplies
 - .1 The uninterruptible power supplies shall be CSA/UL/ULC listed.
 - .2 The uninterruptible power supplies shall be supplied and installed as shown on drawings.
 - .3 Specified product for Security Cabinet: APC Smart-UPS 1500VA LCD RM 2U 120V

PART 3: EXECUTION

3.1 INSTALLATION

- .1 Install all systems in accordance with manufacturer's printed instructions and manufacturer best practices.

***** END OF SECTION *****

PART 1: GENERAL

1.1 SUMMARY

- .1 Communications Copper Horizontal Cabling
 - .1 Horizontal cabling for voice and data circuits shall be 23 AWG; 4-pair Unshielded Twisted Pair CMP/FT6 rated and is independently verified for compliance. Cable shall meet or exceed all TIA/EIA Category 6A requirements.
 - .2 All communication cabling from IT Room to Work Area Outlets (voice, data, wireless access point, etc) shall be Category 6A.
 - .3 All communication cabling from Security CCTV cabinet in IT Room [24] to Security Camera/CCTV outlet locations shall be Category 6A.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, wood, corrugated cardboard packaging material in appropriate on site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal, wiring and plastic materials from landfill to metal/plastics recycling facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.
- .6 Dispose of unused paint material of at official hazardous material collections site approved by Departmental Representative.
 - .1 Do not dispose of unused paint material into the sewer system, into streams, lakes, onto ground or in any other location where it will pose health or environmental hazard.

PART 2: PRODUCTS

2.1 OWNER FURNISHED

- .1 All products are new by contractor.

2.2 MANUFACTURED COMPONENTS

- .1 Acceptable Manufacturers:
 - .1 Belden
- .2 Product Options:
 - .1 Belden 10GXS13 Category 6A Copper UTP Cable - CMP-rated (Typical Data)
 - .2 Belden 10GX13 Category 6A Copper UTP Cable - CMP-rated (Security)
 - .3 Cable Colours:

- .1 All Category 6A UTP cable designated for horizontal cables shall have a blue outer jacket for Voice, Data, and Wireless Access Points.
- .2 All Category 6A UTP cables designated for CCTV/Security cameras shall have a Yellow outer jacket.

PART 3: EXECUTION

3.1 INSTALLATION

- .1 Install all systems in accordance with manufacturer's printed instructions as well as manufacturer best practices.
- .2 All copper horizontal cables shall be installed in the following manner:
 - .1 Cable raceways must not be filled greater than the maximum fill for the particular raceway type.
 - .2 Cables must be installed in continuous lengths from origin to destination (no splices) unless specifically addressed in this document.
 - .3 Where cable splices are allowed, they shall be in accessible locations and housed in an enclosure intended and suitable for the purpose.
 - .4 The cable's minimum bend radius of four (4) times the cable diameter and maximum pulling tension of 25 lbs. shall not be exceeded.
 - .5 If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of four-foot intervals – at no point shall cable(s) rest on acoustic ceiling grids or panels.
 - .6 Horizontal distribution cables shall be bundled in groups of not greater than forty (40) cables. Attention to cable bundle size must be taken; excess of forty (40) cables may cause deformation of the bottom cables within the bundle.
 - .7 Cable shall be installed above fire-sprinkler and systems and shall not be attached to the system or any ancillary equipment or hardware.
 - .8 The cabling system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
 - .9 Cables shall not be attached to ceiling grid or lighting support wires.
 - .10 Where light support for drop cable legs is required, the Contractor shall install "J" Hooks to support the cabling.
 - .11 Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.
 - .12 Cables shall be identified by a self-adhesive label in accordance with the System Documentation Section of this specification.
 - .13 The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.
 - .14 Unshielded twisted pair cable shall be installed so that there are no bends less than four times the cables outside diameter (4 X cable O.D.) at any point in the run.
 - .15 Pulling tension on 4-pair UTP cables shall not exceed 25-pounds for a single cable or cable bundle.

- .16 Cables shall be dressed and terminated in accordance with the recommendations made in the TIA/EIA-568.2-D document, manufacturer's recommendations, and/or best industry practices.
- .17 Pair untwist at the termination shall not exceed 0.25 inch for connecting hardware.
- .18 Cables shall be neatly bundled and dressed to their respective panels or blocks. The combing of cables can be done if the manufacturer supports this cable dressing technique.
- .19 Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- .20 The cable jacket shall be maintained as close as possible to the termination point and must be keeping with manufacturer guidelines.
- .21 Each cable shall be clearly labelled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support Velcro ties.
- .22 Cable labels shall not be obscured from view.
- .23 No plastic or metal cable ties are permitted. Only hook-and-loop cable ties are to be used.
- .24 Pulling lubrication is not permitted unless the cable manufacturer approves the product prior to installation.

***** END OF SECTION *****

PART 1: GENERAL

1.1 COMMUNICATIONS COAXIAL HORIZONTAL CABLING

- .1 Horizontal cabling for CATV / TV shall be 75-ohm RG6, Coaxial cable CMP/FT6 rated and be independently verified for compliance. Cable shall meet or exceed all ANSI/SCTE 74.2003 requirements.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section
- .2 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .3 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .4 Collect and separate for disposal paper, plastic, polystyrene, wood, corrugated cardboard packaging material in appropriate on site bins for recycling in accordance with Waste Management Plan.
- .5 Divert unused metal, wiring and plastic materials from landfill to metal/plastics recycling facility as approved by Departmental Representative.
- .6 Fold up metal banding, flatten and place in designated area for recycling.
- .7 Dispose of unused paint material of at official hazardous material collections site approved by Departmental Representative.
- .8 Do not dispose of unused paint material into the sewer system, into streams, lakes, onto ground or in any other location where it will pose health or environmental hazard.

PART 2: PRODUCTS

2.1 OWNER FURNISHED

- .1 All products are new by contractor.

2.2 MANUFACTURED COMPONENTS

- .1 Manufacturer List:

- .1 Belden

- .2 Product Options

- .1 RG6 -75-ohm Braided Coaxial Cable –CMP/FT6

- .1 The coaxial cable shall be RG6 – 75-ohm, installed in conduit or fully enclosed cable tray above plenum ceilings. Riser/FT4 rated cable may only be used in EMT, enclosed Risers or in area of floor without plenum ratings.

- .1 Physical Characteristics:

Quantity: As per drawings

Conductors: 18 AWG Solid-centre copper conductor

Insulation: Polyolefin

Cable Core: Insulated foamed copper conductor + aluminum polyester shield (100%)
+ copper braid (min 90% coverage)

Jacket: PVC for FT4, FEP for FT6

.2 Transmission Characteristics:

DC Resistance @ 20°C, max.: 10.2 Ω/100m

Impedance: 75 Ω

Attenuation @ 500 MHz <15 dB / 100m

Return Loss 5-1000Mhz <20dB

.3 Mechanical Characteristics:

Minimum recorded installation temp.: 5°C (40°F)

Temperature Rating: 60°C (140°F)

Nominal Outside Diameter: 5.9mm/0.235in

Minimum bend radius: 4X O.D. at 20° C ±1° C

.4 Qualifications

Meets or exceeds requirements of ANSI/SCTE 74.2003 standard

Cable Colours:

Black for Riser Rated, White for Plenum rated

PART 3: EXECUTION

3.1 INSTALLATION

- .1 Install all systems in accordance with manufacturer's printed instructions and manufacturer best practices.
- .2 Contractor shall bring all coaxial cables to a common location at the plywood backboard closest the racks. Cables shall be labelled and coiled neatly with at least 15-feet of slack.
- .3 All coaxial horizontal cables shall be installed in the following manner:
 - .1 Cable raceways shall not be filled greater than the maximum fill for the particular raceway type.
 - .2 Cables shall be installed in continuous lengths from origin to destination (no splices) unless specifically addressed in this document.
 - .3 The cable's minimum bend radius of 4 times the cable diameter and maximum pulling tension of 25 lbs. shall not be exceeded.
 - .4 If a J-hook or trapeze system is used to support cable bundles all horizontal coaxial cables shall be supported at a maximum of four-foot intervals – at no point shall cable(s) rest on acoustic ceiling grids or panels.
 - .5 Horizontal distribution cables shall be bundled in groups of not greater than 16 cables (cable bundle quantities in excess of 16 cables may cause deformation of the bottom cables within the bundle).

-
- .6 Cable shall be installed above fire-sprinkler and systems and shall not be attached to the system or any ancillary equipment or hardware.
 - .7 The cabling system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
 - .8 Cables shall not be attached to ceiling grid or lighting support wires.
 - .9 Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.
 - .10 Cables shall be identified by a self-adhesive label in accordance with the System Documentation Section of this specification.
 - .11 The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.
 - .12 Coaxial cable shall be installed so that there are no bends less than four times the cables outside diameter (4 X cable O.D.) at any point in the run.
 - .13 Pulling tension on cables shall not exceed 25-pounds for a single cable or cable bundle.
 - .14 Cables shall be neatly bundled and dressed to their respective panels or blocks.
 - .15 Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
 - .16 The cable jacket shall be maintained as close as possible to the termination point.
 - .17 Each cable shall be clearly labelled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support Velcro ties.
 - .18 Cable labels shall not be obscured from view.

***** END OF SECTION *****

PART 1: GENERAL

1.1 SUMMARY

- .1 Communications Faceplates and Connectors
 - .1 Modular furniture faceplates and Wall faceplates shall contain Category 6A jacks for Data, Voice and other technology components. The quantity of cables is represented on the drawings.
 - .2 Ceiling or wall-mounted outlets designated as being for wireless access points or security cameras or labelled as 'CCTV' or 'WAP' respectively shall contain Category 6A jacks, matched with the cable type. The quantity of cables is represented on the drawings.
 - .3 Refer to drawings for locations of floor mounted outlets, ceiling mounted outlets and wall/raceway mounted outlets.

PART 2: PRODUCTS

2.1 OWNER FURNISHED

- .1 All products are new by Contractor

2.2 MANUFACTURED COMPONENTS

- .1 Acceptable Manufacturers:
 - .1 Belden
- .2 Product Options:
 - .1 Horizontal Copper Cabling termination modules:
 - .2 Category 6A modules shall all be green with exception to cables for CCTV which shall be yellow.
 - .3 All UTP modules shall be Belden MDVO Category 6A modules and shall have the following minimum performance parameters:
 - .1 Physical Characteristics:
 - Quantity: Determined by floor plans.
 - Dimensions: 23.8 x 16.2 x 34.7 mm (0.94 x 0.64 x 1.34 in.)
 - Materials:
 - Module snap-in: fire retardant plastic, UL94V-0, (*color)
 - Protective cap: fire retardant plastic, UL94V-0, clear
 - IDC housing: fire retardant plastic, UL94V-0, white
 - ID tab: polypropylene (*colour)
 - IDC Module:
 - IDC clip material: copper alloy with nickel plating
 - Encapsulated clips, in fire retardant, UL94V-0, plastic support, black
 - Modular Jack:
 - Contact Material: copper alloy with 50 micro-inches gold over nickel
 - .2 Technical Specifications:

IDC Module: Gas tight connection – insulation slicing of 22 and 24AWG (0.64, and 0.51 mm) plastic insulated solid copper conductors

Durability: 10 insertions of any combination of wire gauge

Modular Jack: 8-pin or 6-pin connector, FCC part 68, Subpart F compliant

8-pin connector is compatible with 6-pin plugs

Durability: 750 mating cycles

.3 Transmission Characteristics:

Designed to exceed the Category 6A standard

Minimum average values measured at 500 MHz with Category 6A plugs

<u>Parameter</u>	<u>Value</u>
NEXT	26.1dB
PSNEXT	23.2 dB
Attenuation	0.10 dB
Return Loss	6.0 dB

.1 Electrical Characteristics:

Current rating: 1.5 Amperes maximum

Insulation Resistance: 500 MOhm minimum

Contact Resistance: 20 mOhm per contact

Dielectric Strength: 1,000 V RMS at 60 Hz for 1 minute

.3 Coaxial Connectors

.1 Coaxial connectors shall be compression style f-type and have a screw type coupling for quick connect/disconnect of coaxial cable at both ends.

.2 F Connectors shall be MDVO style for faceplates and/or patch panels.

.4 Modular Furniture Outlets

.1 Appropriate modular furniture faceplates shall be used and determined by modular furniture brand. Use four (4) port modular furniture faceplates to match furniture selected. Supply blanks for unused ports.

.2 The faceplates shall be mounted in the appropriate knockouts in the furniture channel.

.5 Surface Raceway mounted Outlets

.1 Appropriate modular surface raceway (e.g. Wiremold) faceplates shall be used and determined by surface raceway brand. Use three (3) port modular surface raceway faceplates to match surface raceway selected.

.2 The faceplates shall be mounted in the appropriate knockouts in the surface raceway and shall be segregated from the electrical raceway section

.6 Wall Faceplates

- .1 Work area wall outlets shall be constructed utilizing single gang, MDVO 4-port faceplates with label windows. Specified Product: AX101437
- .2 Wall Phones will be supplied with a single outlet metal faceplate, with metal mounting studs for the phone.
- .3 Data/voice outlets shall be loaded with modular jacks. Faceplates shall contain labelling.

PART 3: EXECUTION

3.1 INSTALLATION

- .1 Install all systems in accordance with manufacturer's printed instructions and manufacturer best practices.

***** END OF SECTION *****

PART 1: GENERAL

1.1 SUMMARY

- .1 Communications Patch Cords, Station Cords, and Cross-Connect Wire.
 - .1 Data cable assemblies for the horizontal cross-connect and the workstation shall be Category 6A RJ-45 to RJ-45 4-pair assemblies.
 - .2 Data, voice and other technology cable assemblies shall be factory-assembled by the manufacturer of the cabling system.
 - .3 Contractors to supply and install two (2) Cat6A patch cables for each Cat6A cable installed.
 - .1 One (1) Patch cable at Equipment room shall be 6-inch to facilitate tidy, interleaved patch-panel and switch layout as shown on drawings.
 - .2 One (1) patch cable at workstation end shall be 10ft
 - .3 Alternate workstation patch cord for Wireless Access Points (WAP) shall be 15ft for WAPs in accessible ceiling areas to allow for easy relocation of WAPs for best coverage. For WAPs in open-ceiling areas with hanging conduit electrical rough-ins, use 6" or 1' patch cables.
 - .4 Patch cables for WAPs in plenum spaces shall be plenum-rated. Contractor shall ensure plenum-rated patch cables are included in shop drawing submittals.
 - .4 Patch cord colours for both IT Room and Work-Area Outlets shall be grey.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section
- .2 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .3 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .4 Collect and separate for disposal paper, plastic, polystyrene, wood, corrugated cardboard packaging material in appropriate on site bins for recycling in accordance with Waste Management Plan.
- .5 Divert unused metal, wiring and plastic materials from landfill to metal/plastics recycling facility as approved by Departmental Representative.
- .6 Fold up metal banding, flatten and place in designated area for recycling.
- .7 Dispose of unused paint material of at official hazardous material collections site approved by Departmental Representative.
- .8 Do not dispose of unused paint material into the sewer system, into streams, lakes, onto ground or in any other location where it will pose health or environmental hazard.

PART 2: PRODUCTS

2.1 OWNER FURNISHED

- .1 All products are new by contractor.

2.2 MANUFACTURED COMPONENTS

- .1 Manufacturer warranty required for all communication structured wiring components.
 - .1 Acceptable Manufacturer: Belden
 - .2 The Project Manager reserves the right to switch out at no additional cost any patch cords to a shorter length. If this does occur, the General Contractor or his representative will notify the Contractor in writing prior to the Cut-Over date.
 - .3 The lengths requested must be common available lengths. If uncommon lengths are requested, the Contractor shall have two (2) weeks to substitute them. If common lengths are requested 48 hours shall be sufficient time to exchange to the desired length.
 - .4 Horizontal Category 6A Patch Cords.
 - .1 The Patch Cords at the Hub Room are to be small outside diameter, 28AWG stranded with exception to cables for CCTV which shall be standard 23 AWG (if Channel Performance Warranty requires solid conductors these must be used to maintain the Warranty) copper conductors (straight through mapping) consisting of 4 pairs that are twisted to form a cable core.
 - .2 The Patch Cords at the work area outlet locations are to be 23 AWG stranded (if Channel Performance Warranty requires solid conductors these must be used to maintain the Warranty) copper conductors (straight through mapping) consisting of 4 pairs that are twisted to form a cable core.
 - .3 The Patch Cords are to be CMR rated and stamped accordingly. The 8-pin modular/8-pin modular Patch Cords are to be consistent with the grade and manufacturer of the Data Cable that is being warrantied.
 - .4 All patch cables within plenum spaces shall be CMP/FT6 rated.
 - .5 The Contractor is required to supply and install all Patch Cords for complete connectivity of Horizontal Cables.
 - .6 Each Patch Cord is to be labelled as per the standards.

PART 3: EXECUTION

3.1 INSTALLATION

- .1 Install all systems in accordance with manufacturer's printed instructions as manufacturer best practices.

***** END OF SECTION *****

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Pathways for Communications Systems**
Section No.: **27 05 28**
Date: August 30, 2024

1 **GENERAL**

1.1 SYSTEM DESCRIPTION

- 1.1.1 Provide a complete telephone and data raceway system consisting of outlet boxes, cover plates, cabling, cabinets, conduits, cabletroughs, pull boxes, sleeves and caps, backboards, fish wires, service poles, and service fittings, required to make a complete and operative system.
- 1.1.2 The system shall be provided to the requirements of the local telephone company, interconnect company and all other authorities having jurisdiction.
- 1.1.3 Install the empty raceway system, including pullstrings, terminal cabinets, outlet boxes, pull boxes, conduit, sleeves and caps, cabletroughs, miscellaneous and positioning material to constitute a complete system. Coordinate with other services.
- 1.1.4 Supply all labour, materials, tools and equipment required to complete the installation in accordance with the full intent of the drawings and specifications.
- 1.1.5 Provide all work in accordance with codes and manufacturers recommendations
- 1.1.6 All pathways including conduits, innerduct and cable tray should be installed parallel or perpendicular to building lines.

2 **PRODUCTS**

2.1 MATERIAL

- 2.1.1 Conduits: In accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- 2.1.2 Junction boxes and cabinets: In accordance with Section 26 05 33.16 – Boxes for Electrical Systems..
- 2.1.3 Outlet boxes, conduit boxes and fittings: In accordance with Section 26 05 32 – Outlet Boxes, Conduit Boxes & Fittings.
- 2.1.4 Cover Plates: In accordance with Section 26 27 26 – Wiring Devices
- 2.1.5 Fish wire: polypropylene type, minimum 3/8" (9 mm) dia.

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3 **EXECUTION**

3.1 **INSTALLATION**

- 3.1.1 Install empty raceway system, including overhead distribution system, fish-wire, terminal cabinets, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, cable troughs, service poles, miscellaneous and positioning material to constitute complete system.

END OF SECTION

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1 **GENERAL**

1.1 CONDITIONS & REQUIREMENTS

- 1.1.1 The Bidding Requirements, General Conditions, Supplementary Conditions, and Division 1 Specifications apply to the Work of this Section.

1.2 SCOPE OF WORK

- 1.2.1 This Section defines the requirements for furnishing and installing the audio, video, control, projection, display and associated systems.

- 1.2.2 Refer to the associated AV, Electrical and Architectural drawings for specific scope of work and installation details.

- 1.2.3 The Work of this Section includes:

- 1.2.3.1 Turnkey audiovisual systems to include all equipment and materials, whether specifically shown or not, to ensure complete and operating systems.

- 1.2.3.2 Submittals and shop drawings for the fabrication, installation, and wiring of said systems.

- 1.2.3.3 Removal of existing AV equipment, including AV cabling, as specified. (see drawing details)

- 1.2.3.4 On-site installation and wiring.

- 1.2.3.5 Adjustment of the systems as herein described and submittal of a testing and adjustment report showing the methods and results for the tests done.

- 1.2.3.6 Training of the Client's personnel in the operation and maintenance of the systems.

1.3 RELATED WORK

- 1.3.1 Contractor shall coordinate with Electrical Contractor on wiring methods, cable testing methods, and conduit/junction box locations for audiovisual equipment and routing of audio, video, control, and power cables/conduits from terminal and pull boxes to system equipment racks.

- 1.3.2 Contractor shall coordinate with Architect/Interior Designer on locations of major AV elements and make sure that Designers on the project are in agreement with the size, position and orientation of major AV elements which would include items such as AV racks, wall or ceiling mounted video

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displays, ceiling mounted video projectors, ceiling mounted and wall mounted loudspeakers and other such elements. Particular attention is required to provide ventilation and cooling inside millwork which contains AV equipment.

1.3.3 Equipment locations, as shown on the drawings, may be relocated +/-5 metres without a change order being required and shall include required cabling and labour at no additional cost.

1.3.4 Related Work: Equipment and materials provided and installed by others, unless otherwise shown in this Section or the Drawings, shall include:

1.3.4.1 Electrical for Audiovisual Systems (Electrical breaker panels required to power the audiovisual equipment, lighting fixtures, dimmer wiring (dimmer to be provided by Electrical contractor), power receptacle outlets, interconnecting wiring for power circuits, conduits, wireways, connection boxes, pull boxes, junction boxes, and outlet boxes)

1.4 STANDARDS

1.4.1 Codes: Work shall be done according to applicable requirements of governing codes, rules and regulations including the following minimum standards, whether statutory or not:

1.4.1.1 Ontario Building Code (OBC)

1.4.1.2 Canadian Electrical Code (CEC)

1.4.1.3 Canadian Standards Association (CSA)

1.4.1.4 Municipal, City, Provincial, and other local codes and requirements.

1.4.2 Standards: Equipment and materials specified shall conform to the current edition of the following standards where applicable:

1.4.2.1 Underwriters Laboratories Canada (ULC)

1.4.2.2 American Society for Testing & Materials (ASTM)

1.4.2.3 National Electrical Manufacturer's Association (NEMA)

1.4.2.4 American National Standards Institute (ANSI)

1.4.2.5 Electrical Testing Laboratories (ETL)

1.4.2.6 Society of Motion Picture and Television Engineers (SMPTE)

1.4.2.7 Electronic Industries Association (EIA)

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1.4.2.8 International Standards Organization (ISO)

1.4.2.9 ANSI/Infocomm Audiovisual Systems Performance Verification Guide , For use with ANSI/InfoComm 10:2013, Audiovisual Systems Performance Verification

1.5 SPECIFIED ELSEWHERE

1.5.1 Certain equipment and materials related to this section are specified in other sections of the overall specification document and are therefore not included in the scope of responsibility of the AV Contractor. Unless otherwise indicated in these specifications, or on the related drawings, these will include the following:

1.5.1.1 Conduit, room lighting fixtures, dimmers, power receptacle outlets, and interconnecting wiring for these circuits, except as specified or indicated herein.

1.5.1.2 Electrical breaker panels required to power the audiovisual equipment.

1.5.1.3 Electrical boxes, junction boxes, pull boxes and conduit as defined in the electrical contract drawings and specifications.

1.5.1.4 Structural work, wall openings, platforms, railings, stairs, fire prevention and safety devices, rough and finished trim, painting and patching, drapes, carpets, floor coverings, computer floors, glazing, acoustical treatments, and heating, ventilating, and air conditioning systems.

1.5.1.5 Furniture, desks, and chairs, except as specified herein.

1.5.1.6 Telecommunications data and fibre-optic cabling as outlined in specification section 27 00 00 and sub-sections.

1.6 SYSTEMS DESCRIPTION

1.6.1 Refer to Associated Architectural drawings and Reference Documents for complete description of rooms and scope of work.

1.6.2 If conflicting information is noted, issue RFI to the Project Manager for clarification before proceeding to finalize, purchase or install materials.

1.6.3 For details regarding systems' equipment descriptions refer to Section 27 41 16 – Integrated Audiovisual Systems Equipment.

1.7 BID SUBMITTAL

1.7.1 Submit bid according to Project Bidding Requirements in addition to the

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requirements of this Section.

- 1.7.2 Submit bids on the basis of the specified equipment, all proposed alternates or alternate proposals are to be priced separately and not to be included in the base bid price.
- 1.7.3 Bid submissions shall be valid for 60 Days
- 1.7.4 Price Submission:
 - 1.7.4.1 Bid response shall include detailed itemized pricing of all equipment to be supplied including quantity, manufacturer and model numbers. The owner reserves the right to delete and/or add equipment from the itemized equipment list and the price shall be adjusted accordingly. The Add and Delete rates for equipment shall be identical.
 - 1.7.4.2 Bid pricing shall include subtotals for each room and/or system type and will be at the owners discretion to use the pricing to increase or decrease project scope
 - 1.7.4.3 The bid response base price shall include a stipulated price to complete all work as outlined in the drawings and specifications.
- 1.7.5 Cable distance estimates, including the requirement of extension devices or alternate cable assemblies, are to be confirmed and included for at time of bidding. "Worst-case" cable length estimates are to be used to ensure adequate cable is supplied to provide a completely functional system as part of the base bid price. Cable distances exceeding the acceptable range for any signal are to be identified at time of bidding.
- 1.7.6 Provide Optional pricing where requested. Optional pricing shall not be included in the base price.
- 1.7.7 The Contractor shall prepare a Compliant Bid return which is 100% compliant with the specified products.
- 1.7.8 The Contractor may provide a separate Voluntary Alternate bid return, where any alternative products can be proposed which are to the benefit of the owner to accept. Technical cut sheets for such alternate products must be included with the bid return. All such Voluntary Alternates will receive equitable consideration.
- 1.7.9 Non-Equipment Costs: Provide non-equipment costs for the Work by the following categories:
 - 1.7.9.1 Engineering: Including required design, drawings, run sheets, engineer stamps etc.

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- 1.7.9.2 Pre-installation: Including fabrication, modification, assembly, rack wiring, etc. performed on the Contractor's premises.
- 1.7.9.3 Installation: Including removal of existing AV wiring and specified equipment, on-site installation and wiring, coordination and supervision, testing and checkout performed on the Client's premises.
- 1.7.9.4 Software Development: Including design, testing, debugging, documentation, etc.
- 1.7.9.5 Documentation: Including, shop drawings, equipment manuals, "As-built" drawings, software instruction manuals and program listings, user instruction panels, etc.
- 1.7.9.6 Training: Including training sessions with Client staff as described in this Section.
- 1.7.9.7 Project Management: Including weekly written reports, project schedule management, and resource management.
- 1.7.9.8 General and Administrative: Overhead expenses, shipping, insurance, taxes, etc.
- 1.7.9.9 Warranty and first year's service.
- 1.7.9.10 Second Year Service Contract: Provide cost for a separate one-year service contract for a second year of maintenance. Include quarterly site visits to inspect, repair, and adjust systems to restore them to original performance standards. Parts and shop labour costs are assumed to be additional. Service contract shall commence after expiration of the original warranty period. The cost for this second year service contract shall not be in the base price.

1.8 GENERAL QUALIFICATIONS

- 1.8.1 Firm has been in business providing similar service for not less than five years.
- 1.8.2 Provide three (3) project references of similar scope successfully completed. Include types of systems installed, total contract amounts, dates completed, and names and telephone numbers to contact.
- 1.8.3 Firm shall provide a list of personnel assigned to the project along with contact information, curriculum vitae, qualifications and certifications relevant to the project. AVIXA CTS certified personnel shall be included in the project team.

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- 1.8.4 Firm shall provide all relevant manufacturer certifications required to purchase, install, program and support the equipment specified.
- 1.8.5 Firm shall have at least one (1) Crestron Certified Master Programmer allocated for this project. Submit Certification(s) in bid response
- 1.8.6 Firm shall have at least one (1) Crestron Certified Digital Media Engineer (DMC-E) allocated for this project. Submit Certification(s) in bid response
- 1.8.7 Firm shall have at least one (1) Q-SYS certified Digital Audio Processor Programmer.

1.9 SHOP DRAWINGS AND SUBMITTALS

- 1.9.1 General: Submit according to Division 1 “Submittals” in addition to the requirements of this Section.
- 1.9.2 Shop drawings:
 - 1.9.2.1 Provide one (1) complete shop drawing package in digital format for review. Once shop drawings have been reviewed and issues corrected provide one (1) print copy and one (1) digital copy on USB drive.
 - 1.9.2.2 Drawings of panels, plates, and designation strips and samples showing engraving, finish and color.
 - 1.9.2.3 Drawings of custom designed consoles, tables, carts, support bases, and shelves
 - 1.9.2.4 Mounting details of all equipment that is to be mounted or suspended from walls and ceilings showing all required accessories
 - 1.9.2.5 Include stamped structural drawings for all custom structures and equipment which exceeds 200lbs (90kg) that is suspended or rigged overhead.
 - 1.9.2.6 Bill of material detailing all equipment provided for the project.
 - 1.9.2.7 Equipment colour selection table for equipment with finish options that have not been identified in the drawings or specifications. Include all available finish options for approval by the Architect
 - 1.9.2.8 Schematic drawings of custom circuitry: Include receptacle pin numbers and component callouts. Show details of custom resistive combining networks, filter, or pads. Show point-to-point wiring drawings for control system modules and interfaces, and for switches and relays.
 - 1.9.2.9 Manufacturer specification sheets for each component being provided. For

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specifications with multiple models identify the model provided by means of highlighting or using a cloud.

- 1.9.2.10 Verification of focal lengths of projection lenses to achieve the specified image sizes.
- 1.9.2.11 Preliminary touch panel layouts and/or UI wireframe design. Provide descriptions of all control functions and all equipment states associated with each function.
- 1.9.2.12 A dimensional plan of the recommended equipment layout for all of the System to be delivered on the assumption that all of the System delivered will be installed at the Site.
- 1.9.2.13 Rack buildouts including calculated BTU, loaded weights, actual and distributed floor or castor loading.
- 1.9.2.14 Particulars of any special requirements in regard to the supply of electricity, rectifying or "smoothing" (power stabilization, device/filter), uninterrupted power supply system, motor generator sets or transformers additional to those normally supplied by a supplier of electricity.
- 1.9.2.15 Equipment rack and patch panel assignment drawings.
- 1.9.2.16 Cable schedule identifying cable signal type, manufacturer, model, connection points and unique cable number. Cable numbers are to match unique cable number on the schematic drawings. Example:

Cable #	Cable Manufacturer	Cable Part#	Cable Type	Signal Type	Start Point	End Point
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- 1.9.2.17 A complete shop drawing package must be submitted for approval prior to purchasing equipment and mobilizing to site.
- 1.9.2.18 The copyright for any such drawings, documentation, etc. created by the AV Contractor for this project shall rest with the Employer

1.9.3 Project closeout:

- 1.9.3.1 Notify the Client and Architect when testing and adjustment of the systems are complete, normal settings marked, and systems are available for acceptance tests. Provide completed copy of the initial testing and adjustment report organized according to the testing requirements in this section.

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- 1.9.3.2 Upon Substantial Performance prepare and submit As-built documentations and manuals. Submission shall be provided in digital format to the AV consultant for review. Once As-built documentations and manuals have been reviewed and issues corrected provide one (1) print copy organized with tabs in a binder and two (2) digital copies on USB drives.
- 1.9.3.3 Manufacturers' operation and maintenance manuals for each piece of equipment.
- 1.9.3.4 "As-built" drawings for all systems are to be submitted.
- 1.9.3.5 As-built drawings must show wiring numbers on plan as described above for every cable in system.
- 1.9.3.6 As-built drawings to be provided in AutoCAD format Version 2017 or newer.
- 1.9.3.7 System programming files in software formats supplied by the manufacturer & programmer are to be included in duplicate on USB drive with the close out submission. Provide uncompiled and compiled code for all programmable included in the AV and control systems. Software and equipment shall be free of passwords unless **all** password credentials are provided with the software. Copyright for any such software programming source code shall rest with the owner.
- 1.9.4 Overall System Operation and Maintenance Manual.
 - 1.9.4.1 Describe procedures necessary to activate each system to provide the functional requirements listed in the System Description. Include normal settings for equalizer, amplifier, signal processing, and user-operated controls (as established during testing and adjustment and modified at final acceptance) in tabular or pictorial form.
 - 1.9.4.2 Operation manuals shall include the following sections. **"Quick Reference"** section shall describe in Non-technical terms for casual users the method of using the facilities in each of the audiovisual equipped spaces. This shall be in the form of a step-by-step operating procedure for each desired feature. Include instruction guides for user interfaces including images of touch screen layouts. This shall form the permanent Users Guide for each room. **"Operation"** section shall describe all typical procedures necessary to activate each system to provide for the functional requirements as listed under the Detailed Specifications. **"Maintenance"** section shall provide a recommended maintenance schedule with reference to the applicable pages in the manufacturer's maintenance manuals. Where inadequate information is provided by the manufacturer, the AV Contractor shall provide the information necessary for proper maintenance. Provide a list of replacement parts necessary and recommended for normal maintenance.

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1.9.4.3 Warranty statement to be provided for equipment, software and quality of work beginning at date of substantial performance for a period of no less than one (1) year. Provide a detailed list of manufacturer and equipment warranty durations with 1 year being the minimum warranty period. Statement shall include a commitment to respond to service request during regular business hours (9:00am-5:00pm) within four (4) hours including an onsite response within 24hrs to resolve the service issue.

1.10 INSTALLATION STANDARDS AND BEST PRACTICES

1.10.1 General: Include the delivery, unloading, setting in place, fastening, wiring interconnections, alignment, adjustment, and other work required of the system components, whether or not expressly shown on the Construction Documents to provide a complete operational system.

1.10.2 Equipment Installation:

1.10.2.1 Mount and brace permanently installed equipment to the building structure to minimize potential damage to personnel or equipment from foreseeable seismic events. Bolt equipment racks to the floor to prevent toppling.

1.10.3 Suspended Equipment & Rigging:

1.10.3.1 All suspended equipment & rigging to be professionally installed by a competent person using rated fasteners, accessories, hardware and methods which have been reviewed in the shop drawing submission. Hang all suspended equipment from ceiling deck, do not use suspended ceiling grid for support of any equipment. Brace all suspended equipment to prevent sway. Include all secondary structural support hardware, e.g. "C" channel, as required to complete the installation.

1.10.3.2 Include in the bid submission stamped structural drawings for all custom structures and equipment which exceeds 200lbs that is suspended or rigged overhead.

1.10.4 Audio System:

1.10.4.1 Cabling methods, termination, grounding and gain structure shall be managed professionally throughout the installation to ensure the system is free from hum, buzz, noise and distortion.

1.10.4.2 The sound system including input lines and loudspeakers shall be checked for polarity by means of a polarity tester. The polarity color-coding shall be identical for every connection type in the system.

1.10.4.3 Ensure the best sonic performance of the sound system is achieved by use

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of high & low pass filters, crossovers, delays, equalizers compression and limiters where available.

- 1.10.4.4 Provide program levels of at least 15 dBA above ambient measured 5 metres from program speakers and speech reinforcement levels of at least 10dBA above ambient everywhere throughout the seating area

1.10.5 Video System:

- 1.10.5.1 Cabling methods and termination shall be managed professionally throughout the installation to ensure the system is free from signal dropout and distortion.
- 1.10.5.2 Ensure all projected images are free from vibration. Use vibration isolation hardware if required to correct vibrations introduced by other building systems.
- 1.10.5.3 Projection systems shall be installed centered and aligned with the projection surface without the need or use of keystone adjustment.
- 1.10.5.4 Verify that the system(s) accurately displays all resolutions required by project documentation on all displays or projectors within the system (i.e., no pixel shift, no geometric distortion, no artifacts from scaling, letterboxing, pillar-boxing, or window-boxing).
- 1.10.5.5 Ensure the video system is capable of the maximum image resolution potential of the display or projector. All video output equipment and inputs locations are to be verified and tested to the display or projector to ensure maximum image resolution potential is reached without image drop out or distortion.

1.10.6 Control System:

- 1.10.6.1 Control system shall provide full functionality of all connected equipment in the system.
- 1.10.6.2 Anticipate one (1) major revision and two (2) minor revisions to the touch panel design and control system functionality.
- 1.10.6.3 Control system shall function without glitches and loss of functionality at time of close out.
- 1.10.6.4 Control systems shall include bidirectional communications to verify the performance of commands.

1.10.7 Cable Installation:

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- 1.10.7.1 Cut all cables to the length dictated by the run. Equipment racks shall include a minimum 6' (2m) service loop and where possible a minimum 3' (1m) service loop for all field devices to accommodate changes or additions in the future.
- 1.10.7.2 All exposed cable bundles are to be enclosed in nylon sleeve or equivalent to protect the cables from damage and provide a clean professional installation.
- 1.10.7.3 Cable Identification:
 - 1.10.7.3.1 Mark all Audio, Video, Control, and other associated audiovisual cables with letter and number text printed on permanent labels created on an ink jet/laser printer or labeling device. Labels shall utilize the same font type, font size, font spacing, and margin spacing.
 - 1.10.7.3.2 Labels will be affixed to cables within 3" (75mm) of both ends.
 - 1.10.7.3.3 Labels will be fabricated from a durable material capable of withstanding moisture, heat, ultraviolet light, chemicals, scratches, abrasions and other wear that may routinely occur at the point of the cable installation
 - 1.10.7.3.4 The labels will be self-adhesive and self-laminating, and will have black text on a white background unless otherwise specified.
 - 1.10.7.3.5 Cable marking shall correspond to identification shown on drawings and/or run sheets.
- 1.10.7.4 Install no cable with a bend radius less than that recommended by the cable manufacturer.
- 1.10.7.5 Provide strain relief for all cables and connections. Provide all connectors with metal shells or casings.
- 1.10.7.6 Group cables according to signals being carried. To reduce signal contamination, form separate groups for the following:
 - 1.10.7.6.1 Power cables
 - 1.10.7.6.2 Control cables
 - 1.10.7.6.3 Video cables or HDBase-T Cat 6 cables
 - 1.10.7.6.4 Audio cables for signals less than minus 20 dBm
 - 1.10.7.6.5 Audio cables for signals between minus 20 dBm and plus 30 dBm

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1.10.7.6.6 Audio cables for signals above plus 30 dBm

1.10.7.6.7 Broadband RF cables.

1.10.7.7 Run power cables, control cables, and high-level cables on the left side of the equipment rack as viewed from the back. Run other cables on the right side of the equipment rack.

1.10.7.8 In plenums, use plenum-rated cable with plenum-rated tie-wraps and supports.

1.10.8 Connections and Termination:

1.10.8.1 All Connections with exposed shield or “drain wires” shall be covered with clear tubing. Cuts in cable jackets that are exposed outside of a connector shell are to be covered with 1” (25mm) of black heat shrink tubing sized correctly for the cable size

1.10.8.2 RF connectors are to be of high quality crimp style connectors with model and impedance matched to cable specifications and equipment requirements.

1.10.8.3 BNC video connectors are to be of high quality crimp style connectors with model and impedance matched to cable specifications and equipment requirements.

1.10.8.4 Audio connections shall use quality connectors with strain relief manufactured by Neutrik or equivalent. Connectors shall be terminated as a balanced connections when possible, unbalanced connections exceeding 25’ (7.5m) shall use a balancing transformer.

1.10.8.5 RJ45 connectors for audio video and control shall have strain relief and the connectors shall be matched to the specified cable required for the signal type

1.10.9 Prefabricated Cables:

1.10.9.1 Quality patch cables are to be used throughout the installation to ensure signal integrity and reliability. Acceptable manufactures for AV cables are Cables to Go, Extron, Kramer, Digiflex, Whirlwind and Canare.

1.10.9.2 Video cables shall be rated and/or certified to carry the maximum resolution potential of the AV system or signal chain.

1.10.10 Plates and Panels:

1.10.10.1 Custom panels and Input/output wall, floor, ceiling plates shall be

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fabricated with 1/8-inch thick #6061-T6 aluminum. Finish to be approved by Architect. Plates shall include engraved text in a contrasting colour to the plate

- 1.10.10.2 Input/output wall, floor, ceiling and rack plate designation shall be clearly identified. Engrave Input/output plates with alphanumeric identification of input/output type (i.e., Mic, line, loudspeaker, video, etc.) and corresponding audio or video patch field designation.
- 1.10.10.3 Patch Panel Assignments: Wire patch panels so that signal “sources” (outputs from) appear on the upper row or a row pair and “loads” (input to) appear on the lower row of a row pair.
- 1.10.10.4 Patch Panel Designation Strips: Use alphanumeric identifications and descriptive information on patch panel designation strips. Number the jack positions in each horizontal row sequentially from left to right. Letter the horizontal jack rows sequentially from top to bottom. Include the alphanumeric identification of each jack on the functional block drawings, and on reproductions of these drawings that shall be mounted in an appropriate location near the patch bays.
- 1.10.11 Equipment Racks and Hardware
 - 1.10.11.1 Equipment racks are to be isolated from the building by means of backboard, wood plinths or isolation pads to suite the rack type and installation.
 - 1.10.11.2 Equipment racks are to include rear rack rails and cable management accessories required to dress the cables in a professional manner. Horizontal and vertical lacing bars are to be used to dress cables into rack equipment.
 - 1.10.11.3 All spare rack space shall be filled with blank rack panels. Rack panels are to be flanged and shall match the finish of the rack. Rack panels shall not exceed 3U in height unless noted otherwise in the drawings and specifications
 - 1.10.11.4 Rack equipment to be installed using security screws and access to the rear of the rack shall include a key lock. Equipment without rack ears shall be secured using a clamping rack shelf.
- 1.10.12 Grounding Procedures:
 - 1.10.12.1 System Grounding: Follow ANSI/TIA 607D for Earthing/Bonding requirements. This is an Equipotential very low impedance meshed bonding network, with a maximum resistance to earth of 100 Milliohms.

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Refer to the referenced standard for more details.

1.10.12.2 Equipment Rack Ground:

1.10.12.2.1 Connect the Secondary Bonding Busbar - SBB (as defined in TIA 607D) to the AV equipment racks with a No 4AWG insulated copper conductor

1.10.12.2.2 All conductive devices or equipment in the AV equipment rooms shall be bonded to the SBB with home run bonding conductors compliant with the TIA 607D standard. This includes cable tray and conduit, in addition to the AV racks noted above.

1.10.12.2.3 The Contractor shall determine that the metallic conduit is properly electrically bonded to the building ground system and electrically bonded to the equipment rack frames.

1.10.12.2.4 The AV Bonding and grounding system is part of the low-impedance Telecommunications Earthing and Bonding network and is bonded to the Electrical Life Safety Earth system.

1.11 PERFORMANCE STANDARDS

1.11.1 Audio Signal:

1.11.1.1 Signal-to-Noise Ratio (including crosstalk): 70 dB minimum

1.11.1.2 Total Harmonic Distortion (electrical): 0.1% maximum from 20 Hz to 20 kHz

1.11.1.3 Frequency Response: ± 0.5 dB, 20 Hz to 20 kHz.

1.11.2 Audio Reproduction:

1.11.2.1 Signal-to-Noise Ratio (including crosstalk): 55 dB minimum

1.11.2.2 Total Harmonic Distortion: 1% maximum from 30 Hz to 15 kHz

1.11.2.3 Frequency Response:

1.11.2.3.1 Speech reinforcement loudspeakers, 4 or 6 in. dia.: ± 1.5 dB 125 Hz to 2.5 kHz rolling off at 6dB/octave from 125 Hz to 80 Hz and at 2 dB/octave above 2.5 kHz as measured on axis of loudspeakers.

1.11.2.3.2 Speech reinforcement loudspeakers, 8 or 12 in. dia.: ± 1.0 dB 100 Hz to 2.5 kHz rolling off at 6 dB/octave from 100 Hz to 63 Hz and at 2 dB/octave above 2.5 kHz as measured on axis of loudspeakers.

1.11.2.3.3 Sub-woofers ± 1.5 dB 35 Hz to 100 Hz, 98dB (1W/1m) sensitivity, 137dB

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max SPL, built in low-pass filter.

- 1.11.2.4 Speech Reinforcement Sound Output Capability: Provide program levels of at least 85 dB measured 5 metres from program speakers and speech reinforcement levels of at least 80 dB everywhere throughout the seating area without objectionable distortion, rattles, or buzzes. Uniformity of coverage for ceiling speakers shall not exceed a variation of 3dB, measured at 1.2m above the floor level, using as a signal input band limited pink noise, but measured at 1KHz using an 1/1 octave band spectrum analyser. Use several different samples of recorded music as test signals and band limited pink noise. Test microphones at each input.
- 1.11.2.5 Sound systems intended for AV playback support must provide a minimum speech intelligibility of 0.56 STI throughout the student seating area.
- 1.11.2.6 Sound systems intended for speech reinforcement must provide a minimum speech intelligibility of 0.67 STI throughout the student seating area.
- 1.11.2.7 Hum and Noise: Hum and noise shall be inaudible under normal conditions from anywhere in the seating area.
- 1.11.3 Video Signal:
 - 1.11.3.1 Digital Video – HDMI 2.0 specification, minimum 18Gb/s bandwidth, applicable to all components in the chain, including cables, switchers, extenders, splitter/DA's and HDBase-T devices
 - 1.11.3.2 Video systems will be required to support VGA/RGBHV type input signals up to a resolution of 1920x1200. VGA inputs must provide EDID emulation or management.
 - 1.11.3.3 All video outputs to display devices shall be digital outputs, with scaling capability provided either by the display device itself or by an external scaler located immediately prior to the display device input. The scalers must be able to maintain the original signal aspect ratio (4:3, 16:10 or 16:9), and should support VGA and Digital HDMI/DP/DVI type computer resolutions and HDTV and 4K resolutions (720P, 1080i, 1080P, Ultra HD, 4K DCI).
 - 1.11.3.4 Video systems will be required to support TMDS digital inputs (DVI-D/HDMI) with minimum resolutions up to 4K. The digital signal input, switching and distribution system must be HDCP compliant (minimum to HDCP2.2). All video systems and cables will support 4K 60 Hz, Rec. 2020, HDR, and NCG.
- 1.11.4 Optical Performance:

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- 1.11.4.1 The total averaged light output from a projector in lumens shall be $\pm 15\%$ of that specified by the projector manufacturer.
- 1.11.4.2 The light falloff from the center of the projected image to four corners as measured at the projected image plane shall not exceed 40%.
- 1.11.4.3 Accurate colour reproduction (must comply with sRGB standards as a minimum and reproduce all coloured light equally and to the required luminance levels for the screen), be free from all perceptible distortion of image shape and size, be free from all perceptible colour banding, skew, hot spots/ dull spots and colour aberration.
- 1.11.4.4 Brightness, contrast ratio and colour gamut requirements of displays will vary according to the site conditions (e.g. ambient light levels) and the technology employed. The contrast ratio of the image display should be designed to comply with the Infocomm PISCR standard.
- 1.11.4.5 Projectors and lenses shall be solidly mounted and braced so that no movement induced by mechanical/motor vibration or walking on floor above is observed in the image.
- 1.11.4.6 Performance of Direct View displays shall be even across the panel with less than 5% non-uniformity from centre to edge of display. There shall be no visible dead pixels or vertical or horizontal bands. Light output in Candelas/Nits shall be within 15% of that specified by the manufacturer.

1.12 SOFTWARE LICENSE

1.12.1 NONDISCLOSURE

- 1.12.1.1 In consideration of the disclosure to the Employer of information relating to all technical aspects of the Deliverables and other proprietary products, technology and/or processes of the AV Contractor, including, but not limited to, drawings, models, photographs, sketches and digital files in any native file format, the Employer agrees:
 - 1.12.1.1.1 to maintain such information (including all portions or copies thereof) confidential in the same manner as its own Employer proprietary information is maintained,
 - 1.12.1.1.2 not to disclose the information (or any portion or copy thereof) to any third party,
 - 1.12.1.1.3 not to use such information (or any portion or copy thereof) for any purpose except maintenance and support of its in-house systems.

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1.12.1.2 The obligations of this Agreement shall not apply to any information which is or which becomes generally known to the public due to publication or by means other than a breach of duty by the Employer or which becomes otherwise available to the Employer through legal sources.

1.12.1.3 The Employer further agrees not to make more than three (3) copies of any document or drawing provided as part of such information.

1.12.2 OBLIGATIONS GOVERNING THE SOFTWARE

1.12.2.1 Title to and exclusive ownership of the Software as licensed hereunder shall at all times remain with the AV Contractor or third party suppliers but the AV Contractor hereby grants to the Employer, or has obtained for the Employer from third party suppliers, successive irrevocable, royalty-free, non-transferable and non-exclusive licences to use the Software as licensed hereunder from the date of this Agreement in perpetuity.

1.12.2.2 The Employer shall have no right to sub-license or part with possession of such Software as licensed hereunder or any part thereof to third parties.

1.12.2.3 The original and all copies of the Software as well as any updates which may be purchased by subsequent agreement shall be and remain the property of the AV Contractor. Title to all applicable rights in patents, copyrights, and trade secrets in the Software will remain with the AV Contractor.

1.12.2.4 The foregoing licenses shall extend to all equipment purchased or utilised by the Employer.

1.12.2.5 Notwithstanding anything to the contrary elsewhere herein, at no time shall the AV Contractor or third party suppliers be precluded or restricted from selling or licensing Software as licensed hereunder identical to the Software as licensed hereunder or any part thereof to other customers.

1.12.2.6 Software as licensed hereunder which is the property of any third party will be assumed to have been licensed by its proprietor to the AV Contractor and such Software as licensed hereunder shall be directly licensed by its proprietor or sub-licensed to the Employer with the consent of the proprietor at no cost to the Employer on the same terms and Clauses as are contained in this Agreement in respect to the AV Contractor's own Software as licensed hereunder.

1.12.2.7 All Software as licensed hereunder will be, if developed exclusively for the Employer, delivered with the development system software tools such as cross-assembler, linker, simulator and utilities. In addition, there shall be delivered Application specific notes and operating manuals for the Software

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and hardware that provide transparent access to the Software and Hardware control topology.

- 1.12.2.8 At the time of submitting the System to the Acceptance Tests, the AV Contractor will supply where applicable and having used its best efforts in the case of third party suppliers (best efforts will be demonstrated to the Employer by copies of correspondence between the AV Contractor and the third party stating the AV Contractor's request and giving the third party statement of compliance or otherwise) to the Employer media which will contain:
 - 1.12.2.8.1 All source code pertaining to the System
 - 1.12.2.8.2 Instructions and full description of equipment required which will enable the Employer to create executable programs from source code
 - 1.12.2.8.3 All executable programs
 - 1.12.2.8.4 Instructions and full description of equipment required which will enable the Employer to prepare operating systems and other third party Software as licensed hereunder for use
- 1.12.2.9 For any Software as licensed hereunder not developed by the AV Contractor all information, data, codes and documentation distributed to the AV Contractor and otherwise available to the AV Contractor.
- 1.12.2.10 The above so submitted Software as licensed hereunder shall be in a form suitable for immediate access by the System.
- 1.12.2.11 In the event that the AV Contractor is unable to supply the source code pertaining to the System the AV Contractor warrants, and the Employer accepts, that at all times the latest version of the source code from the AV Contractor or any third party supplier has been deposited, at even date of this Agreement, and is available for inspection by the Employer during normal business hours at any time. The AV Contractor further warrants that the Independent Source Code Depository has been instructed and has acknowledged that the deposited source code will be released to the Employer upon insolvency of the AV Contractor.
- 1.12.2.12 If the Employer discovers an error in the coding or the logic of the Software as licensed hereunder and as supplied under the terms of this Agreement to the Employer, which prevents the System from performing in accordance with the performance requirements of this Agreement, the Employer shall notify the AV Contractor of the error and upon request by the AV Contractor will deliver to the AV Contractor its analysis thereof accompanied by complete program, module, data listings and sample runs

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exhibiting and rectifying the error.

1.12.2.13 The AV Contractor shall from time to time notify the Employer of the availability of newer versions of the supplied Software as licensed hereunder which the AV Contractor or any third party supplier has released for use by its customers generally and shall, within sixty (60) days of receipt of written request by the Employer, supply such newer version to the Employer. Any such Software as licensed hereunder provided must be documented as to:

1.12.2.13.1 The fault being corrected (if any)

1.12.2.13.2 The enhancement it represents

1.12.2.13.3 The restrictions imposed or removed

1.12.2.13.4 Details of modifications to and differences from the version to be replaced.

1.12.2.14 The Employer shall assist the AV Contractor in its performance under the terms of this Agreement by allowing the AV Contractor to use the Employer's System, data listings and sample runs to reproduce and/or correct the reported error and to install and check updated versions of the delivered Software licensed hereunder.

1.12.2.15 The AV Contractor represents and warrants that it is the owner or Licensee of the supplied Software as licensed hereunder and has the right to permit the Employer to use the same. The AV Contractor shall not be liable for any incidental or consequential damages, whether foreseeable or not, even if the AV Contractor has been advised of the possibility of such damages, resulting from or in any way connected with the use of the supplied Software as licensed hereunder.

1.12.2.16 The AV Contractor shall defend any suit or proceeding brought against the Employer and shall pay any adverse judgement entered therein so far as such suit or proceeding is based upon a claim that the use of the Software as licensed hereunder furnished by the AV Contractor under this Agreement constitutes infringement of any copyright or patent, provided the AV Contractor is promptly notified in writing and given authority, information and assistance (at the AV Contractor's expense) for the defence of same; and the AV Contractor shall, at its own expense and at its option, procure for the Employer the right to continue to use the said Software as licensed hereunder, or to replace the same with a non-infringing release. The foregoing shall not be construed to include any agreement by the AV Contractor to accept any liability whatsoever in respect to copyrights or patents for inventions including more than the Software as licensed and

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furnished hereunder, or in respect of copyrights or patents for methods and processes to be carried out with the aid of said Software as licensed hereunder, except those which are inherent in said System as furnished. The foregoing states the entire liability of the AV Contractor with regard to copyright and patent infringement as related to the delivered Software as licensed hereunder.

- 1.12.2.17 The Employer acknowledges the rights of the AV Contractor and third party suppliers in and to the Software as licensed hereunder, including, but not limited to, computer programs, user manuals, other supporting material and data, identifying symbols, passwords, user numbers and security symbols, and further acknowledges that such are properly considered to be trade secrets in that they involve processes and compilation of the information which are secret, confidential and not generally known to the public, and which are the product of the AV Contractor's own expenditure of time, effort, money and creative skills. The Employer also acknowledges and agrees that the use of the Software as licensed hereunder is on a confidential basis for the sole and exclusive use by the Employer and not for resale, and agrees that it will not use, publish, disclose or otherwise divulge to any person, except necessary employees of the Employer, at any time, either during or after the termination of this Agreement, nor permit its employees to so divulge any such information regarding the software as licensed hereunder, without the prior written consent of an officer of the AV Contractor, except that the Employer is authorised hereby to reproduce information derived from the software as licensed hereunder for its own internal use by authorized employees. Notwithstanding the foregoing, the proprietary and secret information covered hereby may be disclosed by the Employer to a third party, person, firm or corporation if such disclosure is unavoidable because of its or their access to or control of the Employer's computers, provided that this sentence shall not be deemed to permit any use of the Software as licensed hereunder which would otherwise be prohibited. Nothing herein shall be deemed to limit any rights of the AV Contractor under copyright, patent or other law.
- 1.12.2.18 The Employer shall use the Software as licensed hereunder solely and exclusively for its own purposes and shall not, without the prior written approval of the AV Contractor, allow any third party to use the Software as licensed hereunder for purposes of any such third party whether or not the Employer is compensated therefore.
- 1.12.2.19 The AV Contractor warrants that a copy of the current and previous version of Software as licensed hereunder submitted to the Employer is available from the AV Contractor.
- 1.12.2.20 Provided that the Employer has obtained, under the terms of this Agreement or subsequent agreements, all items, such as but not limited to

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source code and compilers, required to modify the Software, the AV Contractor hereby grants the Employer the right to modify and to enhance the Software as supplied and licensed under the terms of this Agreement at its own risks and expense and further agrees such modifications and enhancements developed by the Employer to be the property of the Employer without prejudice to the rights of the AV Contractor to the basic Software. The Employer furthermore is under no obligation to notify the AV Contractor of any such modifications and enhancements.

- 1.12.2.21 The Employer warrants that all Software used for the duration of the warranty period is the Software as licensed hereunder and released from time to time by the AV Contractor to the Employer. Failure by the Employer to use the Software as licensed hereunder and released by the AV Contractor will constitute the conclusion of the warranty period as defined under the terms of this Agreement.
- 1.12.2.22 Any new version of Software as licensed hereunder and delivered to the Employer by the AV Contractor during the warranty period, under the terms of this Agreement which is deemed, and advised so by the AV Contractor, to rectify a failure which occurred during the operations of an event will cause the warranty period for the Software as licensed hereunder to restart.
- 1.12.2.23 The AV Contractor hereby warrants the right by the Employer to any corrective Software updates for the next ten (10) years.
- 1.12.2.24 The AV Contractor restricts any enhancements to Software as licensed hereunder to the latest release of Software as licensed hereunder only.
- 1.12.2.25 The AV Contractor warrants that all contracts, contacts and arrangements between the AV Contractor and all third party Software suppliers providing Software as licensed hereunder will transfer to the Employer with the successful completion of the Final Acceptance.
- 1.12.2.26 The Employer warrants to inform the AV Contractor of all its dealings with third party Software suppliers supplying software as licensed hereunder for the duration of the warranty period.
- 1.12.2.27 The AV Contractor warrants that at no charge to the Employer it will reply to verbal queries from the Employer PROVIDED THAT :
- 1.12.2.27.1 The queries relate to the System provided by the AV Contractor pursuant to this Purchase Agreement
- 1.12.2.27.2 The query is raised by Employer staff or an authorised agent of the

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Employer

- 1.12.2.27.3 The query is during the AV Contractor's normal business hours
- 1.12.2.27.4 The Employer's representative or employee has attended standard basic training in the use of the System as provided by the AV Contractor
- 1.12.2.27.5 The Employer warrants that the use of this service is not intended as a vehicle for design consultation.
- 1.12.2.28 The Employer may make copies of the Software in any machine readable form for back-up purpose only. Any such copies made by the Employer will include the AV Contractor's copyright notice, together with any other proprietary notices. The Employer will take all reasonable steps to ensure that the whole or any part of the Software is not reproduced or copied (save as aforesaid) by any employee, licensee, invitee or agent of the Employer or any other person under the control of the Employer and shall observe all reasonable security in relation to the storage, filing and use of the Software and basic materials. The Employer shall not sell, lease, rent, assign, transfer, deliver or otherwise part with possession of the licensed Software or permit any other person, firm or company to inspect or use the Software in any way provided that the external auditors formally appointed by the Employer shall have the power to inspect and have access to the Software held on Employer premises at any time.
- 1.12.2.29 The Employer acknowledges that in acquiring the right to use the Software it has relied upon its own skill and judgement in the selection thereof and in the use and result it intends to obtain therefrom.

1.12.3 SOFTWARE LICENCE

- 1.12.3.1 The AV Contractor warrants that it has the right to grant this Software Licence(s) for the use of the Software and that the Licences for Software supplied pursuant to this Purchase Agreement authorise the Employer to use the licensed Software in machine readable form on the processing devices which form part of the Employer's computer processing facilities so designated by make and model in respect of which this Licence is granted. If the designated processor is inoperative for any reason, any Licence granted under this Agreement shall be extended to authorise the use of the licensed Software on a back-up processing unit until the designated processor is available again. If a designated processor is to be permanently phased out of operation and replaced by another processor, this Licence may be transferred to a replacement processor at no costs or liability to the AV Contractor upon written notification to the AV Contractor of the new processor make and model. For the purpose of this Agreement, use is defined as copying for processing any portion of the instructions or data in

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any licensed software from storage units or media into the designated processor, to the extent authorised above, into another processing unit in the event of malfunction.

1.12.3.2 Any additional licences for Software and/or modifications, alterations and amendments to the licensed Software granted to the Employer by the AV Contractor shall be subject to:

1.12.3.2.1 The terms of any supplemental agreement between the parties, and

1.12.3.2.2 The conditions of this Agreement insofar as they do not conflict with the terms of the supplemental agreement.

1.13 SUB-CONTRACT

1.13.1 No sub-contract will be permitted for the AV Contractor's responsibilities, as herein defined, unless specifically identified in the bid submission and approved by the Employer.

1.13.2 The AV Contractor shall have sole responsibility for the satisfactory implementation of each system, even though the AV Contractor may have sub-contracted a portion of the installation or had certain manufacturers install their own equipment.

1.14 SCHEDULE OF IMPLEMENTATION

1.14.1 The AV Contractor shall obtain from the Prime Contractor a chart showing projected dates when the relevant areas will be available for the on-site installation and indicating the various pertinent terminal dates after award of Contract for completion of design, pre-installation work, on-site installation work, testing and acceptance.

1.14.2 If the AV Contractor feels that there will be any problems with meeting the scheduled program dates, the Prime Contractor must be informed at the earliest possible opportunity.

1.15 COOPERATION WITH OTHER TRADES

1.15.1 It shall be the responsibility of the AV Contractor to cooperate at all times, and to the fullest extent, with all trades doing work in the building, to the end that lost time, work stoppages, interference, and inefficiencies do not occur.

1.16 DELIVERY, STORAGE AND HANDLING

1.16.1 Bear costs of shipping to the site and unusual storage requirements. Make appropriate arrangements and coordinate with authorized personnel at the site for proper acceptance, handling, protection, and storage of delivered

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equipment.

1.17 WARRANTY

- 1.17.1 Warranty the entire system for a minimum of one year from the date of system acceptance by the Client. Component warranties shall be honoured for the term established by the manufacturer, if greater than one year. In case of system or equipment malfunction include site visits to check and adjust equipment and restore systems to original performance standards. Provide all equipment, material, and labour at no charge to the Client.
- 1.17.2 Begin manufacturers' equipment warranties in Client's name to commence on the date of acceptance. For Contractor modified equipment, the manufacturer's warranty is normally voided. In such cases, give the Client a warranty equivalent to that of the original manufacturer.

1.18 EMPLOYER TRAINING

- 1.18.1 The AV Contractor shall provide on-the-job training by a suitably qualified instructor, to personnel designated by the Employer, to instruct them in the operation and maintenance of the systems. In the event the AV Contractor does not have qualified instructors on staff for certain sophisticated equipment, a manufacturer's representative for such instruction will be provided by the AV Contractor at no additional cost to the Employer.
- 1.18.2 All training shall take place after the systems are operational, but before the acceptance tests. There shall be a minimum of 8 hours (2 half days) of training on the systems included in this specification

1.19 SECURITY

1.19.1 Requirements Included:

1.19.1.1 Provide a project security program, to:

- 1.19.1.1.1 Protect Work, stored products and construction equipment from theft and vandalism.
- 1.19.1.1.2 Protect premises from entry by unauthorized persons.
- 1.19.1.1.3 Protect Employer's operations at site from theft, vandalism or damage from AV Contractor's work or employees.

1.19.1.2 Maintenance Of Security

- 1.19.1.2.1 Initiate security program in compliance with Employer's system, prior to job mobilization.

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- 1.19.1.2.2 Maintain security program throughout construction period, until Employer occupancy or Employer acceptance precludes the need for AV Contractor security.

2 EXECUTION

2.1 EXAMINATION

- 2.1.1 Verify that electrical requirements including junction boxes, floor boxes, ceiling loudspeaker enclosures, empty conduit, power circuits, and receptacles are in place as shown on the drawings. Notify the Prime Contractor in writing as soon as possible of any discrepancies or omissions.

2.2 SYSTEM ACCEPTANCE TESTS

- 2.2.1 System acceptance tests shall not proceed until the initial system checkout and adjustment report has been submitted and approved by the AV Consultant. After approval of the report proceed as follows:

2.2.1.1 Verify that all equipment in the Contract Documents is on-site.

2.2.1.2 Demonstrate the operation of all systems to the Owner, Prime Contractor and Audiovisual Consultant.

2.2.1.3 Proceed with subjective listening and viewing tests to demonstrate the systems.

2.2.1.4 Have personnel and test equipment on hand prepared to reproduce the tests documented in the approved checkout and adjustment report.

2.2.1.5 If further adjustments are required or defective equipment must be repaired or replaced, the acceptance tests may be suspended or continued at the option of the Client and Architect.

2.2.1.6 If further adjustments are required, continue work until the installation operates properly. Continuing work may include, but may not be limited to, changes to or adjustments to mixing and levels, readjustment of loudspeaker aiming, adjustment of system equalizers, programming changes to the control system, and convergence of video projectors.

2.2.1.7 If acceptance of the system is delayed because of defective or non-performing equipment, reimburse the Client for any expenses incurred for rescheduling system acceptance tests.

2.3 CLEANUP AND REPAIR

- 2.3.1 Upon completion of the Work, remove refuse and rubbish from the premises.

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Leave work areas and equipment clean and in a like-new state. Repair damage caused by the installation of the Work of this Section at no cost to the Owner.

2.4 PROTECTION OF WORK

- 2.4.1 During the installation up to the date of final acceptance protect all work against damage and loss. In case of damage or loss, replace or repair such work at no cost to the Client.
- 2.4.2 Upon completion of the Work, remove refuse and rubbish from the premises. Leave work areas and equipment clean and in a like-new state. Repair damage caused by the installation of the Work of this Section at no cost to the Owner.

***** **END OF SECTION** *****

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1 **EQUIPMENT**

1.1 GENERAL REQUIREMENTS

- 1.1.1 Supply the latest model, available at the time of bidding, of each piece of equipment.
- 1.1.2 Supply materials and equipment that are new and that shall meet or exceed the latest published specifications of the manufacturer.
- 1.1.3 Equipment and materials should be CSA and ULC certified. If certification is not available for a specified product the contractor will obtain certification through inspection by the Local Authority Having Jurisdiction.
- 1.1.4 Equipment and materials should be sourced from Canadian manufacturers, if possible. Specified equipment not manufactured in Canada should be sourced through authorized Canadian distribution.
- 1.1.5 Any products which have been discontinued by their manufacturer after the tender has been awarded shall be replaced with that manufacturer's current replacement model at no additional expense to the project. If no replacement product is available from the manufacturer an appropriate alternative may be offered by the contractor and shall be subject to consultant's approval before implementation.

2 **PRODUCTS**

2.1 TABLETOP VIDEO CONFERENCE SYSTEM

- 2.1.1 The Tabletop Video Conference (VC) System shall consist of tabletop UC conference device with 7" 1280x800 pixel display, an ePTZ camera, 360° quad microphone array, and a HDMI extender receiver.
- 2.1.2 The ePTZ camera shall have the following:
 - 2.1.2.1 1080p at 30Hz
 - 2.1.2.2 5X digital zoom
 - 2.1.2.3 92° horizontal and 65° vertical fields of view
 - 2.1.2.4 RJ-45-to-USB-C adaptor for USB-C connection
 - 2.1.2.5 Manufacturer's camera mounting bracket

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2.1.3 The microphone array shall have the following:

2.1.3.1 Four (4) cardioid electret elements

2.1.3.2 20' (6metre) 360 ° pickup range

2.1.4 The microphone pod(s) shall have the following:

2.1.4.1 Three (3) microphone elements

2.1.4.2 20' (6 meter) 360 ° pickup range

2.1.5 The VC system shall have the ability to add a maximum of two (2) additional microphone pods

2.1.6 The VC system shall have one (1) HDMI input, one (1) USB-C input, one USB-A, and one (1) RJ-45 HDMI extension output connections

2.1.7 The tabletop VC system shall connect to the owner's network via a RJ-45 jack supporting a 10/100/1000 Mbps Ethernet connection. and 802.11a/b/g/n/ac Wi-Fi.

2.1.8 Approved product is: Crestron UC-MX70-U which includes:

2.1.8.1 CCS-UC-1-X tabletop conference system (TC-001 on drawings)

2.1.8.2 UC -CAM-L1 ePTZ camera (CAM-001 on drawings)

2.1.8.3 HD-RX-USB-2000-C HDMI extender receiver

2.1.8.4 CCS-UCA-MIC microphone pod (TM-001 on drawings)

2.2 HD VIDEO MULTI-FORMAT CABLE SYSTEM (VS-001 ON DRAWINGS)

2.2.1 Multi-format cable system should include 6' connection cables for HDMI, USB-C, Mini DisplayPort and DisplayPort devices.

2.2.2 System should automatically select devices' HD video when connected via HDMI automatic switcher

2.2.3 System shall have a maximum input resolution of 4096X2160

2.2.4 Approved manufacturer is: Crestron

2.2.5 Approved products are:

2.2.5.1 4X1 HDMI switcher - HD-MD4X1-4KZ-E

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2.2.5.2 HDMI cable - CBL-HD-THIN-HS-6 (6-foot/1.8 metre)

2.2.5.3 Mini DisplayPort cable - CBL-4K-MDP-HD-6 (6-foot/1.8 metre)

2.2.5.4 USB-C cable - CBL-4K-USBC-HD-6 (6-foot/1.8 metre)

2.2.6 Approved DisplayPort cable is: Kramer C-DPM/HM-6 (6-foot/1.8 metre)

2.3 TABLE MONUMENT (TB-001 ON DRAWINGS)

2.3.1 Table monuments shall be of all metal construction, with a retracting lid, that mount flush into a tabletop, lectern, or other flat surface up to 44mm thick

2.3.2 Monuments will be modular with twelve slots arranged in two rows of six.

2.3.3 Table monuments will be furnished with the following connections:

2.3.3.1 Dual US NEMA 5 AC power outlets

2.3.3.2 USB-A and USB-C charging ports

2.3.3.3 Dual RJ-45 CAT6 ports

2.3.3.4 Cable pass-through plates to accommodate one HDMI, one DisplayPort+, one Mini DisplayPort and one USB-C cable.

2.3.3.5 Any unused module slots shall be filled by blank plates

2.3.4 Approved product is: Crestron FT2-700-ELEC-B

2.3.5 Approved connectivity modules are:

2.3.5.1 FT2A-PWR-US-2 Dual US NEMA 5 AC power outlet

2.3.5.2 FT2A-CHDR-USBA/C USB-A and USB-C charging port

2.3.5.3 FT2A-CBL-PT-CAT6 Dual RJ-45 CAT6 port

2.3.5.4 FT2A-PLT-10 cable pass-through plate

2.3.5.5 FT2A-PLT-BLANK-10 blank plate

2.4 SOUND BAR SPEAKER

2.4.1 Sound bar will have stereo balanced 10K Ω line-level inputs.

2.4.2 Frequency response for sound bar will be 100Hz to 20kHz +/- 3dB.

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2.4.3 Sound bar shall have a minimum output sensitivity of 83dB @ 1W @1 m.

2.4.4 Sound bar will provide and amplifier power of 20 Watts per channel.

2.4.5 Sound bar will provide and amplifier power of 20 Watts per channel.

2.4.6 Approved product is: Crestron Saros SB-200-P

2.5 FLAT PANEL DISPLAYS

2.5.1 The flat panel displays shall have at least 2 HDMI 2.0 digital inputs.

2.5.2 The digital inputs must be HDCP compliant.

2.5.3 The flat panel displays must have a minimum native resolution of 3840 x 2160 and support all HDTV resolutions plus standard computer resolutions.

2.5.4 The displays' brightness should be a minimum of 350 Nits at full white.

2.5.5 The displays should be LED edge-lit LCD commercial grade display.

2.5.6 The displays must be controllable via 3rd party control systems, such as Crestron. RS-232 or LAN is accepted as a control interface.

2.5.7 Displays must have a minimum of a 3 year warranty.

2.5.8 Approved products are:

2.5.8.1 75" – HG75NT690UFXZA (DP-001 on drawings)

2.6 DISPLAY MOUNTS

2.6.1 Display mounts must accommodate the standard VESA® mounting hole patterns appropriate for each display for which they are intended, additional patterns supported with adaptor plates.

2.6.2 Display mounts must have an appropriate weight capacity for the displays for which they are intended.

2.6.3 Tilt adjustable from +15° to -5° unless otherwise noted.

2.6.4 Approved manufacturer: Peerless

2.6.5 Approved products are:

2.6.5.1 For 75" display – ST650

2.7 7" SCHEDULING PANEL (TP-001 ON DREAWINGS)

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- 2.7.1 The Room Scheduling Panel shall have a 1280X800 (WXGA) 16:10 7” (diagonal) active matrix colour LCD display with 5-point multi-touch capacitive overlay
- 2.7.2 Scheduling panel shall connect to the owner's network via RJ-45 100Mbps LAN connection and be PoE+ powered.
- 2.7.3 The scheduling panel shall interface directly with Microsoft Exchange Server, Google Calendar, Ad Astra or CollegeNet 25Live software applications.
- 2.7.4 The scheduling panel shall have two USB ports for optional room availability accessories.
- 2.7.5 The scheduling panel shall fit in a standard 2-gang electrical box (2G) and will come complete with a mullion-mount kit (MM) or multi-surface mounting kit (MS) as required.
- 2.7.6 The scheduling panel shall come complete with a light bar for visual confirmation of availability status.
- 2.7.7 Approved product is: Crestron TSS-770-(B/W)-S-LB KIT

2.8 CUSTOM FABRICATION

- 2.8.1 Electrical Power Connections: Others will provide electrical power junction boxes and circuits. Provide required interconnections to the power system from these junction boxes to the equipment and equipment racks.
- 2.8.2 Remote control panels and Receptacle Plates: Fabricate with 1/8-inch thick #6061-T6 aluminum. Finish to be approved by Architect.
- 2.8.3 Remote Control Touchpanel layouts – Contractor shall provide full colour touchpanel layouts for each page for the Consultant and Owner review, prior to final commissioning. Additionally, the Contractor must supply a functional description of control activity associated with each touchpanel page.
- 2.8.4 Equipment Rack: Provide power-receptacle strips with “U” ground outlets. Power-receptacle strips shall be mounted on the rear interior of the rack space on the left side as viewed from the back. Insulate power-receptacle strips from the rack. Power-receptacle strips shall be Middle-Atlantic Company or approved equal. Provide a ULC approved 3W LED work light and switch mounted in the cabinet above the rack's so as to illuminate the racks during servicing and operation.
- 2.8.5 Project Information Label: Permanently mount an engraved plate with filled lettering on contrasting background at the top facing edge of each equipment rack. Plate shall identify:

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“Design by The HIDI Group, Toronto, Ontario, 416-364-2100” and “Installation by Contractor, City, Province, Phone Number.”

- 2.8.6 Audio Transformers: Provide appropriate impedance ratio and power handling capacity for the function intended for the audio transformers specified.
- 2.8.7 Networks and Pads: Provide networks and pads as shown on the Drawings or as required to achieve proper impedance matching and appropriate sound levels.
- 2.8.8 Rack Mount Adapters: Provide the appropriate factory or custom rack mount adapters for equipment installed in the audiovisual equipment rack, whether specifically itemized or not.
- 2.8.9 Rack Mounting Security Hardware: Provide security hardware for all equipment and security covers for equalizers, crossovers, signal delay, and other adjustable signal processing equipment.
 - 2.8.9.1 Install equipment using Torx or Square Drive screws. Use same type of hardware throughout the project.
 - 2.8.9.2 Install security covers on equalizers, crossovers, signal delay, and other adjustable signal processing equipment that do not require user access.
 - 2.8.9.3 Do not install security covers on equipment such as Blu-Ray players and DVD's that require user access.
 - 2.8.9.4 Provide nylon flat washers or shoulder washers on all fasteners used in front panels of equipment mounted in racks.
 - 2.8.9.5 Mount all equipment faces flush with each other. Provide shims behind mounting flanges, if necessary, to make all face plates flush with each other.
 - 2.8.9.6 Install trim strips over rack screws.
 - 2.8.9.7 Provide Client with two of each appropriate specialty tool for all security hardware.
- 2.8.10 System Functional Diagrams: Provide reduced-size, as-built functional diagram for the control, audio and video system. Frame drawing with an acrylic cover or laminate and mount next to the equipment rack.

2.9 CABLES AND CONNECTORS

- 2.9.1 Cables: Refer to drawings for cable type specifications:

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2.9.1.1 Plenum-rated tie-wraps and supports: Thomas & Betts TYV525M

2.9.2 Receptacle Plate Connectors: Unless otherwise shown, use the following types of panel receptacles on connection boxes, panels, plates, and wireways:

2.9.2.1 Microphone: XLR-3 (female) – Wall Plates

2.9.2.2 Microphone: Switchcraft Tini QG (Mini-XLR-3) (female) – Flush poke-through floor boxes

2.9.2.3 Audio Line Level Input (from computer): 1/8-inch (3.5mm) diameter tip/ring/sleeve type. Insulate from panel.

2.9.2.4 Audio line level output: XLR-3 (male) – Wall plates

2.9.2.5 Audio, Line Level Consumer Grade unbalanced – Canare Flush mount RCA, insulate from Panel

2.9.2.6 Loudspeaker Level: Neutrik Speakon twist-lock. Insulate from panel.

2.9.2.7 Video: Canare Flush-mount BNC type, 75Ω. Insulate from panel.

2.9.2.8 VGA (RGBHV Analogue Video) - DB-15

2.9.2.9 RJ-45: Keystone Category 6

2.9.3 CAT6 Shielded Twisted Pair Video Cable (HDBaseT, Crestron Digital Media)

2.9.3.1 bandwidth. Each cable will be tested after installation with a level V scanner such as the Fluke Versiv DSX platform and test reports indicating all cables pass Category 6 standards “post install” shall be part of the as-built documentation.

2.9.3.2 Must include end to end foil shield with 100% coverage

2.9.3.3 Must include 4 pairs of 23 AWG solid copper conductors

2.9.3.4 Maximum overall cable diameter is 0.280"

2.9.3.5 Must be available in both plenum and non-plenum rated versions

2.9.3.6 Approved manufacturers are: Belden, Commscope, Nexans/Berk-Tek, General Cable, Crestron

2.9.4 HDMI Cables:

2.9.4.1 Must be minimum Premium High Speed certified and tested to 600MHz.

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- 2.9.4.2 Must support minimum data transfer rate of 18 Gbps, and minimum 48bit colour depth
- 2.9.4.3 Cables shorter than 15' in length must support a minimum resolution of 2160p/4K UHD at 60Hz
- 2.9.4.4 Cables greater in length than 15' must be AWG 24 conductor size and support a minimum resolution of 2160p/at 30Hz
- 2.9.4.5 Must support a minimum of 8 high-bandwidth, uncompressed multichannel audio streams
- 2.9.4.6 Must include high quality, gold plated connectors
- 2.9.4.7 Must be highly flexible. Overly rigid, thick, or otherwise difficult to manage cable types will be rejected.
- 2.9.4.8 Where cable runs are longer than those attainable with standard HDMI cabling, appropriate transmitter/receiver extender sets, HDBaseT extenders, or signal boosters shall be installed.
- 2.9.4.9 Cables shall include factory manufactured ends. Modular cables (Rapid Run, etc.) will be rejected.
- 2.9.4.10 Approved manufacturers: Belkin, Crestron, Cables To Go, Extron, Kramer

3 **EXECUTION**

3.1 **STANDARDS**

- 3.1.1 Installation of all equipment and cabling shall conform to standards as laid forth in Section 27 41 00 Subsection 1.10 – Installation Standards and Best Practices
- 3.1.2 The equipment utilized in AV system, and the overall system itself, shall conform to the performance standards as laid forth in Section 27 41 00 subsection 1.11 – Performance Standards.

***** **END OF SECTION** *****

PART 1: GENERAL**1.1 COPYRIGHT**

- .1 Copyright to these Division 28 Specifications is retained by Hidi Group Consulting Engineers Inc. The use of these Specifications is granted to the City of Toronto solely for their use on the Shelters Program – Shelter Renovation located on 2299 Dundas Street West, Toronto, ON.

1.2 BUILDING SECURITY SYSTEM (BSS) DOCUMENTS

- .1 The requirements of the Project Manual are related to and shall be read in conjunction with this section.
- .2 The contract documents for the Building Security System (BSS) include the following Division 28 documents:
 - .1 Section 28 00 00 – BSS General
 - .2 Section 28 05 00 – BSS Installations – General
 - .3 Section 28 05 13 – BSS Installations – Electrical
 - .4 Section 28 08 00 – Testing and Inspections
 - .5 Section 28 08 01 – Documentation
 - .6 Section 28 08 02 – Training
 - .7 Section 28 13 13 – Access Control and Alarm Monitoring System
 - .8 Section 28 13 26 – ACAMS Field Devices
 - .9 Section 28 23 00 – Video Surveillance System
 - .10 Section 28 26 00 – Security Intercom System
 - .11 City of Toronto Corporate Security

1.3 DEFINITIONS

- .1 "OWNER" shall mean City of Toronto or their appointed representative.
- .2 "ARCHITECT" shall mean the Project Architect.
- .3 "ELECTRICAL ENGINEER" shall mean the Project Electrical Engineer, The Hidi Group Consulting Engineers Inc.
- .4 "CONSULTANT" shall mean the Project Security Consultant, HIDI Security Consulting, an operating name of The Hidi Group Consulting Engineers.
- .5 "CONTRACTOR" shall mean the BSS Contractor who shall provide the Building Security System.
- .6 "GENERAL CONTRACTOR" shall mean the project general contractor.
- .7 "ELECTRICAL CONTRACTOR" shall mean the project electrical contractor or Subcontractor.
- .8 "BSS" shall mean the complete Building Security System.

- .9 "FURNISH" shall mean purchase and deliver to the appropriate installing Contractor/Subcontractor or equipment manufacturer, complete with every appurtenance, document, commission and Warrant.
- .10 "PROVIDE" shall mean furnish, install, commission, test and warranty.
- .11 "COMPONENT" shall mean any individual item of equipment, software or material, which is an element of the BSS.
- .1 The above definitions shall apply to the words when they are in the upper case, when they are in lower case and when they are capitalized.
- .1 Words used in the singular shall not be construed as limiting to one item where other requirements of the contract documents or the scope of work require multiple items and associated accessories in order to provide a fully functional BSS meeting all of the requirements detailed in the contract documents.
- .2 When a specific reference to a manufacturer of a product is made, and the terms "or approved equal" are used, substitutions of a product by another manufacturer or model will be allowed, but the substituted product must conform to all specified requirements. A submission including a compliance statement and technical information must be made to the Consultant for consideration. The Consultant determination on the acceptability of substitutes shall be final. Approved substitution equipment shall conform to available space, functional, and power requirements. Substituted equipment that does not conform to the requirements shall be replaced or required modifications made at no additional cost to the Owner.
- .12 When a specific reference to a manufacturer of a product is made, and the terms "or alternate with credit" are used, substitutions of a product by another manufacturer or model with a cost credit will be allowed. A submission including a compliance statement, technical information, and cost implication must be made to the Consultant for consideration. Areas where the product is not in compliance with the Specifications shall be clearly noted. The Consultant determination on the acceptability of substitutes shall be final. Approved substitution equipment shall conform to available space, functional, and power requirements. Substituted equipment that does not conform to the requirements shall be replaced or required modifications made at no additional cost to the Owner.

1.4 ABBREVIATIONS

- .1 The following abbreviations shall apply to this and all subsequent sections of the Specifications:
- | | | |
|-------|---|--|
| ACAMS | - | Access Control and Alarm Monitoring System |
| BSS | - | Building Security System |
| CCTV | - | Closed Circuit Television |
| CIS | - | Computer Interface Station |
| CO | - | Control Output |
| CPU | - | Central Processing Unit |
| DRS | - | Digital Recording System |
| DVR | - | Digital Video Recorder |
| FAS | - | Fire Alarm System |
| HEACS | - | Hotel Electronic Access Control System |
| ICP | - | Intelligent Control Panel |
| ID | - | Identification |
| IDS | - | Intrusion Detection System |
| MI | - | Monitored Input |
| NAS | - | Network Attached Storage |
| NDR | - | Network Digital Recorder |
| NDS | - | Network Data Server |
| NSW | - | Network Switch |
| OIW | - | Operator Interface Workstation |
| PCS | - | Parking Control System |
| RAM | - | Random Access Memory |
| REX | - | Request to Exit |

RFI	-	Request for Information
RFP	-	Remote Field Panel
RM	-	Remote Module
SAN	-	Storage Area Network
SER	-	Security Equipment Room
SIS	-	Security Intercom System
SMD	-	Security Monitoring Desk
VBS	-	Video Badging System
VDW	-	Video Display Wall
VMD	-	Video Motion Detection
WDS	-	Web Data Server
WDU	-	Wall Display Unit
WFP	-	Workstation Flat Panel

1.5 SCOPE OF WORK

- .1 Provide a complete BSS turnkey installation as detailed in this and other sections of these specifications. The BSS shall comprise of the following systems:

- .1 An IP-based Access Control and Alarm Monitoring System (ACAMS) throughout the facility as detailed on the BSS drawings and in compliance with section 28 13 13 and 28 13 26 of these specifications. ACAMS shall be connected to and utilize the property's security network for communication. ACAMS head end is existing and end and is located off site.
- .2 Access cards shall be supplied by the client.
- .3 An IP-based Video Surveillance System (VSS) throughout the facility as detailed on the BSS drawings and in compliance with section 28 23 00 of these specifications. VSS shall be connected to and utilize the property's security network for communication.
- .4 An IP-based Security Intercom System (SIS) capable of two-way real-time communication between the substation and master station locations. Substations will be purpose-built for the function and installed location. Provide throughout the facility as detailed on the BSS drawings and section 28 26 00 of these specifications. SIS shall be connected to and utilize the property's converged network for communication.
- .5 An IP-based Intrusion Detection System (IDS) throughout the facility as detailed on the BSS drawings and in compliance with section 28 16 00 of these specifications.
- .6 Provide integration from the BSS to other systems as follows:
 - .1 Connect BSS components to barrier-free equipment and coordinate with door hardware provider to ensure all functionality and sequencing is in compliance with Building Codes and does not cause electrical or mechanical conflict on each respective system. Provide all necessary components and coordination.
- .7 Testing, scheduling and inspections as specified in section 28 08 00 of these specifications.
- .8 Training as specified in section 28 08 02 of these specifications.
- .9 The following City of Toronto Security documents will be shared post-tender with the selected Security sub-contractor:
 - .1 CITY OF TORONTO CORPORATE SECURITY – ACCESS CONTROL SYSTEM INSTALLATION STANDARD.
 - .2 CITY OF TORONTO CORPORATE SECURITY ACCESS CONTROL SYSTEM INSTALLATION AND SYSTEM REQUIREMENTS.

- .3 CCURE 9000 PROGRAMMING STANDARDS.
- .4 TORONTO CORPORATE SECURITY – STANDARD FOR IP VIDEO SURVEILLANCE SYSTEM.
- .2 Provide the following support for the BSS components:
 - .1 Installations in compliance with industry best practices, and in compliance with sections 28 05 00 and 28 05 13 of these specifications.
 - .2 Submittals, samples and record documentation as specified in section 28 08 01 of these specifications.
 - .3 Coordination with other site subcontractors.
 - .4 Reporting to the Owner, the Architect and Consultant for the coordinated and timely execution of the Work.
 - .5 1 year warranty on all components furnished, beginning from date of substantial performance/completion.
 - .6 Maintenance services during the warranty period.
 - .7 All power supplies and conditioners, interlocking and control relays, equipment enclosures, conduit and cable trays, junction and mounting boxes, cabling, access doors, sleeves, fire stopping and other components, software, materials and services required for a completed and fully operational turnkey BSS installation meeting these specifications.

1.6 BSS GENERAL CRITERIA

- .1 The BSS shall meet the following general criteria:
 - .1 All BSS control equipment, including but not limited to: system control panels, networked devices, workstations, interface devices shall be fully IP networked, microprocessor based, and feature real time distributed processing. All networked devices shall reside on a common security network, provided as detailed in the BSS drawings and these specifications.
 - .2 The BSS shall be configured to ensure reliability of systems operation and control of critical functions/systems. The following describes, in very general terms, a relationship between the various components of the BSS that would be acceptable. Other BSS topologies shall be acceptable if they meet the intent and performance requirements defined in these specifications.
 - .1 Where requested in the BSS drawings and specifications, provide a BSS Local Area Network (LAN) to serve the BSS system(s). The Security LAN shall be a high speed Ethernet TCP/IP based network compliant to telecommunications standards, with either a copper or fiber backbone sufficient to support 10Gbs of network activity.
 - .2 Any Intelligent Control Panels (ICP's) shall be network based, communicate natively via TCP/IP, and connect to the BSS LAN for communication to the ACAMS server. The network connection shall be via a direct on-board RJ-45 connection on the ICP. The use of code or protocol converters (cobox) is not permitted.
 - .3 Any Remote Modules (RM's) (specific system required control or monitoring panels if required) that are subcomponents of ICP's shall be directly connected to their corresponding ICP via dedicated cabling referred to as panel cabling. If physically possible, the RM's shall be located within the same room as the ICP, otherwise in approved locations as agreed upon by the owner and consultant.
 - .4 Field devices connected to RM's or ICP's shall be directly connected via dedicated

cabling. This cabling shall be compliant to the device's functional requirements, manufacturer's recommendations, and these specifications.

1.7 WARRANTY AND SERVICES DURING THE WARRANTY PERIOD

- .1 The Warranty Period for all components of the new BSS and their installation shall be a minimum of one (2) years from the date of Substantial Performance. The date of Substantial Performance shall be the date when all components have been certified by the Consultant and accepted by the Owner to be complete in accordance with the definition of Substantial Performance.
- .2 All components and their installations shall be free from defects. Any defective material or workmanship and any resulting damage to work of other trades shall be replaced or repaired as directed during the Warranty Period. Comply with General Conditions, agreeing to repair or replace any components of the BSS that have failed within the warranty period.
- .3 Schedule repair work with the Owner's representative to prevent interference with normal building activities.
- .4 The Base Tender price shall include the cost of all replacement parts during the warranty period and all of the associated installation costs and all of the costs associated with the repair of components during the warranty period but shall not include the cost of labour for routine maintenance during the warranty period. The cost of labour for routine maintenance during the warranty period shall be provided separately as an Alternate Price as detailed below.
- .5 Replace or repair all supplied defective installations. Respond and be on site within four hours of the Owner placing a system trouble call for items of a critical, urgent or immediate nature (e.g. failed head end component, non-functioning controller, etc.). Response to Warranty call out by the Owner shall be within 24 hours for items not requiring immediate attention. Work to trouble shoot and identify the cause of the BSS or component failure shall begin immediately and shall continue until repaired to the satisfaction of the Owner.
- .6 Any software modifications or upgrades that become standard product offerings from the BSS Contractor and/or BSS equipment vendors during the warranty period shall be brought to the attention of the Owner and, at the discretion of the Owner, may be requested and, if so, shall be provided at no additional cost to the Owner.
- .7 The BSS Contractor shall maintain an inventory of commonly replaced components in the local office for the replacement of failed components. Larger components shall be readily available within the North America for overnight courier shipping response.

1.8 CODES, PERMITS AND APPROVALS

- .1 Obtain all required permits, such as Magnetic Lock Installation Permits, and any other security –related inspection certificates. All permits and certificates shall be made available to the Owner.
- .2 The latest requirements of all national, provincial, county, municipal and other authorities having jurisdiction shall be met.
- .3 Work that is not clearly defined by local ordinance or amendment shall be governed by the Canadian Building Code, the Ontario Building code and the Canadian Electrical Code.
- .4 The requirements of The Occupational Health and Safety Act (OHSA), Environmental Protection Act (EPA), Americans with Disabilities Act (ADA), Accessibility For Ontarians With disabilities (AODA) and CSA Barrier Free Design Standards shall be followed for all job-site procedures and installation methods.
- .5 Work shall be performed in compliance with Owner's insurance underwriters' requirements which will be provided to the successful BSS proponent following project award.
- .6 All equipment and materials furnished under this subcontract shall be new, and shall meet all applicable

UL/ULC standards and all requirements of these specifications.

1.9 SCHEDULE

- .1 Complete all requirements of the BSS subcontract prior to the scheduled Substantial Performance date for each portion of the work.
- .2 Provide to the General Contractor a schedule indicating the sequence of work, durations of individual tasks, delivery dates for all material, devices and equipment and detail any interface that must be coordinated with any other subcontractors.
- .3 Attend all project meetings as requested by the Owner and the General Contractor.
- .4 Provide written status reports at required intervals and in a format acceptable to the Owner. An updated schedule of work shall be included in each status report.
- .5 Comply with the Project Construction Schedule. Provide additional staff and work overtime as required to comply with the Project Schedule and so as not to interfere with other on-site subcontractors in their effort to comply with the Project Schedule.
- .6 Provide written Request for Information notices to the Owner when specific information or clarification of the specifications is required. Request for Information notices shall be provided at least two weeks prior to the need for the information.

1.10 CONTRACTOR QUALIFICATIONS

- .1 The Contractor shall:
 - .1 Be certified by the manufacturer to procure, install, program, maintain, and service the acceptable BSS components.
 - .2 The Contractor must have permanent full-time certified staff available in the Toronto area to perform all necessary project cycle installation functions, including service and maintenance work following system acceptance.
 - .3 Have staff and be able to supply information to support that their current installation and service technicians are competent factory trained and certified personnel capable of maintaining and servicing the proposed system.
 - .4 Have a proven record of experience with similar in the supply and installation of equivalent systems over a minimum period of five years. Document at least three and no more than six projects, of equal or greater size and complexity, on the acceptable BSS components. Indicate quantities of card readers, CCTV cameras, and SIS units included in the scope of the projects along with a description of the property secured.
 - .5 Have been a factory certified representative for the ACAMS, CCTV, and SIS products indicated, for a minimum of three years entailing design, installation, configuration, and maintenance.
 - .6 Have comprehensive local service and support facilities in the Toronto area for the total BSS as provided.
 - .7 Maintain local supplies, or have access to a factory authorized organization that shall carry a complete stock of essential and expendable parts.

1.11 SYSTEM COMPLIANCE AND PERFORMANCE CERTIFICATION

- .1 The BSS Contractor shall thoroughly review all aspects of the BSS Design Documents and certify that their bid submission and proposed BSS facilities are in compliance with the Contract Documents. The Contractor shall provide a compliance review ("Compliance Review") of all Specifications and Addenda as

part of the Contractor's proposal. The Compliance Review will be an item-by-item list and review of the Specifications. The BSS Tender Respondents shall clearly identify any areas where the proposed BSS facilities are not in full compliance with the BSS design. An accompanying performance statement and technical supporting documentation must be supplied for consideration.

- .2 Unless an exception is specifically noted in the Compliance Review, it is assumed that the Contractor is in complete compliance with the Contract Documents. Exceptions taken in cover letters, subsidiary documents, by omission or by contradiction do not release the Contractor from being in complete compliance unless the exception has been specifically noted (explicitly, not by implication) in the Compliance Review.

***** END OF SECTION *****

PART 1: GENERAL

1.1 WORK OF THIS SECTION

- .1 This section of the specification details the components to be provided by the BSS Contractor relating to BSS Installations - General.

1.2 RELATED REQUIREMENTS

- .1 The requirements of the Project Manual are related to and shall be read in conjunction with this section.
- .2 This section is related to and shall be read in conjunction with all other Division 28 sections.
- .3 This section is related to and shall be read in conjunction with the BSS drawings.

PART 2: REQUIREMENTS

- .1 Equipment, materials, devices and facilities shall meet, at minimum, the following requirements:
 - .1 Manufactured by experienced manufacturers of the specific components and facilities.
- .2 All equipment and materials shall be manufactured using new and high-quality components, without defects. All field devices of each system shall be products of one manufacturer with unified shape, colour, design, function, operation, and markings.
 - .1 Design shall minimize the requirement for field repair or maintenance.
 - .2 Modular design to allow expansion without substantial modification of existing installed components.
 - .3 Internal or self-diagnostics for component failures.
 - .4 Maintainable on a unit basis without affecting the ongoing operation of the balance of other systems.
 - .5 Modular components, test ports and cable terminations shall be accessible.
 - .6 Damage caused by the failure of one component will be limited to the component that has failed without affecting the ongoing operation of the systems.
- .3 Equipment and materials shall be provided with an Underwriters Laboratories, Inc. (U.L.) and Canadian Standards Association C.S.A label wherever applicable.
- .4 Hazardous Materials Notification: In the event that a product or material that does not contain asbestos, PCB, or other hazardous materials as determined by the Owner is not available, a "Material Safety Data Sheet" (MSDS) equivalent to OHSA Form shall be submitted for the proposed product or material prior to installation.
 - .1 Asbestos and PCB Certification: After completion of installation, but prior to Substantial Performance, the BSS Contractor shall certify in writing that products and materials installed, and processes used, do not contain asbestos or polychlorinated biphenyls (PCB).

2.2 EQUIPMENT - MOUNTING AND FINISHES

- .1 Fire rated or U.L. /U.L.C. listed doors and frames shall not be drilled, cut or modified in any way without prior approval from the Architect. Doors or frames that require modification to meet the Contract Document requirements shall be brought to the attention of the Architect. Replace any door or frame that has been modified without the approval from the Architect.

- .2 Visible panel and instruction labels shall be in compliance with the CSA Barrier Free Design Standards as approved by the Architect. Graphics for all equipment in areas accessible by the public shall be approved by the Architect.
- .3 Visible security BSS contractor identification logos, trademarks, or evidence of their removal are not permitted on any equipment, or devices, etc. that are located in publicly-accessible, and viewable spaces. Equipment, devices or enclosures accessible to the public shall utilize tamper proof fasteners or manufacturer-installed locks.
- .4 Final mounting locations shall be verified with the Architect prior to installation. Notify the Architect if a particular location is not acceptable for the application.

2.3 AMBIENT CONDITIONS

- .1 Provide equipment, devices and materials for interior applications that shall be capable of withstanding and operate satisfactorily in, at minimum, the following ambient conditions:
 - .1 10 to 45 Deg. Celsius temperatures.
 - .2 10-90 percent relative humidity (non-condensing).
 - .3 Electrical power service of single phase, 85-110 percent of 120 Vac, 60 Hz nominal.
- .2 Provide equipment, devices and materials for exterior applications that shall be capable of withstanding and operate satisfactorily in, at minimum, the following ambient conditions:
 - .1 -40 to 50 Deg. Celsius temperatures.
 - .2 10 - 100 percent relative humidity.
 - .3 Electrical power service of single phase, 85-110 percent of 120 Vac, 60 Hz nominal.

PART 3: PRODUCTS

3.1 PANELS

- .1 Provide panels and enclosures for all components of the BSS which are susceptible to physical or environmental damage. Equipment or devices that are not equipped with enclosures, as a specified unit shall be mounted within panels or enclosures that meet, at minimum, the following requirements:
 - .1 NEMA 1 rated painted steel panels with locking door.
 - .2 Ventilated to prevent excessive heat build-up, where required.
 - .3 Field cabling shall be terminated on a terminal strip or directly on the component PCB fixed within the enclosure. Provide strain relief as necessary.
 - .4 Internal components shall be installed to allow easy access for diagnostics, maintenance, removal or replacement of any component within the enclosure.
 - .5 Cabling shall be neatly installed within wire guides with removable covers for easy access.
- .2 Interior panels and enclosures within plenum areas shall meet, at minimum, the following requirements:
 - .1 Approved plenum rated panel with locking door and gasketing as required.
 - .2 Field cabling shall be terminated on a terminal strip or directly on the component PCB fixed within the enclosure. Provide strain relief as necessary.

- .3 Internal components shall be installed to allow easy access for diagnostics, maintenance, removal or replacement of any component within the enclosure.
- .4 Cabling shall be neatly installed within wire guides with removable covers for easy access and additional service-loop spare cabling common in best industry installation practices.
- .3 Exterior and garage mounted panels and enclosures shall meet, at minimum, the following requirements:
 - .1 NEMA 4 painted steel panels with locking door.
 - .2 Field cabling shall be terminated on a terminal strip or directly on the component PCB fixed within the enclosure. Provide strain relief as necessary.
 - .3 Internal components shall be installed to allow easy access for diagnostics, maintenance, removal or replacement of any component within the enclosure.
 - .4 Cabling shall be within wire guides with removable covers for easy access.
- .4 All panels shall be lockable with the same key, which shall be unique to the building. Provide the Owner with ten keys.
- .5 Panels and enclosures are only allowed at the ACAMS RFP locations as indicated on the Security Drawings.
- .6 Provide cabling diagrams laminated in clear plastic at each field panel enclosure showing all cable terminations, relays, interlocks, power supplies, etc.
- .7 Provide heat output and space conditioning requirements to the Owner and Architect for all BSS components.

3.2 LABELLING

- .1 Provide labelling for all ICP's, RFP's, other panels and enclosures. Labelling shall meet, at minimum, the following requirements:
 - .1 Plastic laminated label, which shall be affixed to the panel or enclosure with rivets or permanent adhesive.
 - .2 Lettering .25 inch high which sharply contrasts with the background.
 - .3 Coordinated with the approved project labelling scheme and consistent throughout the project.
 - .4 Indicated on the record documentation.

3.3 SECURITY EQUIPMENT RACK

- .1 Install all required security system equipment as detailed within these documents within the racks provided by others in the Main IT room. Refer to the detail drawings within the security drawings for equipment locations and rack quantities.
- .2 Provide all mounting hardware and supports as necessary to mount the equipment within the racks.
- .3 Provide heat output and space conditioning requirements to the Owner and Architect for all BSS components.

PART 4: EXECUTION

4.1 BORING AND PATCHING

- .1 Provide boring and patching of work as required for a complete BSS. Boring and patching shall meet, at minimum, the following requirements:
 - .1 Before boring any structural or fire rated components, obtain the Architects' approval.
 - .2 Make boring with clean, square and smooth edges. Patches shall be inconspicuous in the final installation.
 - .3 Restore fire ratings if boring has violated the fire rated assemblies.

4.2 SLEEVES, CUTTING, PATCHING AND FIRE STOPPING

- .1 The Contractor shall be responsible for the timely placing of sleeves as detailed on the Drawings and the Coordination Drawings for all piping and conduit through walls and partitions, beams, floors and roofs as noted below, while the same are under construction:
 - .1 All concrete or masonry construction.
 - .2 Wall constructions where the penetration must be sealed air tight. Patches for penetrations through walls for Work installed prior to finish application shall be provided by others. 13mm (½")
 - .3 Fire rated wall construction.
- .2 Sleeves shall be at least one size larger than the size of conduit or pipe, including the insulation where applicable; it serves except where "Link Seal" casing seals are used in sleeves through walls below grade. Sleeves shall be sized such that the annular space between the sleeve and the conduit will not be less than 13mm (½"). All conduits passing through concrete or masonry walls above grade shall be at least 18 gauge galvanized steel sleeves. Sleeves shall be set flush with finished wall. All sleeves in floors shall extend a minimum of 50mm (2") above the finished floor. Sleeves installed in fire rated construction shall be of suitable length and diameter to accommodate the firesafing system used. Sleeves set in concrete floor construction shall be at least 16 gauge, galvanized steel. Where the conduit passes through a sleeve, no point of the conduit shall touch the sleeve and the conduit shall be centred in the sleeve.
- .3 Seal all penetrations in fire rated construction with factory built devices or with manufactured fill, void or cavity materials "Classified" by Underwriters Laboratories, Inc. for use as a Through Penetration Firestop. All firestop devices and systems shall be approved for such use by the authorities having jurisdiction. The firestop system used shall maintain the fire resistance rating of the building component that is penetrated. Firestop systems and devices shall comply with ASTM E 814 (UL 1479) for all types of penetrations being sealed. Submittal data for firestop systems shall include the applicable UL System Numbers. Excessive shrinkage of the firestop materials, which would permit the transmission of smoke or water prior to exposure to a fire condition, is unacceptable. Where a mastic coating is used to seal the surface of the firestop, the mastic shall be non-hardening. The firestop manufacturer's representatives shall instruct the Contractor's representatives in the proper installation procedures so that the penetrations on the Project will be installed in accordance with the UL listing and the manufacturer's recommendations. If it complies with these Specifications, firestop-sealing component/system as manufactured by one of the following manufacturers will be acceptable:
 - .1 Tremco Fire Resistive Joint System using Dymeric sealant and Cerablanket-FS mineral filler or,
 - .2 Specified Technologies, Inc. SpecSeal Systems or,
 - .3 3M Fire Barrier Penetration Sealing Systems or,
 - .4 GE Pensil Firestop Sealant by General Electric or,
 - .5 International Protective Coatings Corp. Flame Safe Systems or,
 - .6 Thermal Ceramics Fire Master Firestop Fire Protection Systems or,

.7 Hilti FS-601 Systems.

- .4 Sleeves penetrating walls below grade shall be standard weight black steel pipe with 1/4" thick steel plate waterseal secured to the pipe with continuous fillet weld. The waterseal plate shall be located in the middle of the wall and shall be 50mm (2") wider all around than the sleeve it encircles. The entire assembly shall be hot dipped galvanized after fabrication. Seal off annular opening between pipe and sleeve with "Link Seal" type casing seal as manufactured by Thunderline Corporation or Innerlynx. The pipe sleeve shall be sized to accommodate the Thunderline casing seal. Casing seals shall be Series 300 for pipe size 20mm (3/4") through 100mm (4") and Series 400 for pipe sizes 125mm (5") and larger. If holes and/or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no additional expense to the Owner. The Contractor shall undertake no cutting or patching without first securing the Architect's written approval.
- .5 All unused sleeves shall be sealed with firestop devices and systems to maintain the fire rating of the construction penetrated.

4.3 HANGING AND SUPPORTING

- .1 Install all equipment, devices, materials and components in compliance with the manufacturer's recommendations. Supports shall be suitable for the environment within which the component is to be installed. Coordinate all hanging and supporting of components with all trades.
- .2 Structural support members shall be galvanized.

***** END OF SECTION *****

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Pathways for Electronic Safety and Security**
Section No.: **28 05 28**
Date: August 30, 2024

1 **GENERAL**

1.1 SYSTEM DESCRIPTION

- 1.1.1 A complete security system consisting of conduits, pull boxes, device boxes and pull wire, required to make a complete conduit system.
- 1.1.2 The system is supplied and installed by the Security Contractor.
- 1.1.3 All 120V power requirement for the security system is to be provided by Division 16, i.e. power for the controller, power for the cameras, etc.
- 1.1.4 The electrical contractor to coordinate work with the security contractor prior to any conduit installation.

1.2 RELATED WORK

- 1.2.1 Conduits: In accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- 1.2.2 Junction boxes and cabinets: In accordance with Section 26 05 33.23 – Boxes for Electrical Systems.
- 1.2.3 Outlet boxes, conduit boxes and fittings: In accordance with Section 26 05 32 – Outlet Boxes, Conduit Boxes & Fittings.

2 **PRODUCTS**

2.1 MATERIAL

- 2.1.1 Conduits: In accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- 2.1.2 Junction boxes and cabinets: In accordance with Section 26 05 33.23 – Boxes for Electrical Systems.
- 2.1.3 Outlet boxes, conduit boxes and fittings: In accordance with Section 26 05 32 – Outlet Boxes, Conduit Boxes & Fittings.
- 2.1.4 Cover Plates: In accordance with Section 26 27 26 – Wiring Devices
- 2.1.5 Fish wire: polypropylene type, minimum 3/8" (9 mm) dia.

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Pathways for Electronic Safety and Security**
Section No.: **28 05 28**
Date: August 30, 2024

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 Install the security conduit, terminal cabinets, pull boxes, pull wires, and miscellaneous positioning material to constitute a complete system. Co-ordinate with other services.
- 3.1.2 Conduits shall not have more than 3-90 deg. or equivalent bends in each run, with the bending radii not less than ten (10) times the conduit dia. Pull boxes shall be provided in each conduit run of over 30m at not less than 30 m intervals.
- 3.1.3 All conduits run in the slab or the ceiling shall be coordinated with other services.

END OF SECTION

PART 1: GENERAL**1.1 WORK OF THIS SECTION**

- .1 This section of the specifications details the requirements for the testing and inspecting of the BSS.

1.2 RELATED REQUIREMENTS

- .1 The requirements of the Project Manual are related to and shall be read in conjunction with this section.
- .2 This section is related to and shall be read in conjunction with all other Division 28 sections.
- .3 This section is related to and shall be read in conjunction with the BSS drawings.

PART 2: REQUIREMENTS**2.1 SCHEDULING**

- .1 Acceptance testing shall comply with the Construction Contract schedule. Corrections or alterations, which have been noted during the acceptance tests, shall be completed prior to the end date called for in the Construction Contract. Retests of deficient items shall be taken into consideration in the scheduling.

2.2 TESTING AND INSPECTIONS - GENERAL

- .1 All components shall be tested by the BSS Contractor to ensure compliance with the Specifications before they leave the BSS Contractor's premises and shall be tested again on-site by the BSS Contractor before the commencement of acceptance testing. The BSS Contractor shall not ship components to the project site until they have been found to be fully compliant with the specifications and the BSS Contractor shall not request the commencement of acceptance testing until such time as the BSS Contractor has made a complete and thorough checkout of all equipment.
- .2 Any piece of equipment, device, or material shall be made available for inspections or tests, as deemed necessary by the Owner and Consultant. Use of the equipment, devices or material shall not imply acceptance of the system or acceptability of any component. Availability and demonstration of the systems shall not be withheld and the use of components shall not imply the start of the Warranty Period.
- .3 Costs associated with the required inspections and testing shall be included in this scope of work. Additional charges shall not be accepted.

PART 3: PRODUCTS**3.1 FACTORY TESTS**

- .1 Components shall be factory tested prior to their delivery to the project. Document test results and submit copies of the testing within the Final Documentation.
- .2 Deficiencies shall be remedied and testing shall be repeated at no additional cost to the Owner prior to the shipping of the components to the project site.

PART 4: EXECUTION**4.1 INSPECTION DURING INSTALLATION**

- .1 Prior to acceptance testing, the BSS shall be available for the use by the Owner. Use by the Owner shall not imply acceptance of the BSS or any components or the commencement of the Warranty Period.
- .2 Provide staff to assist the Consultant in the inspections made during the installation period to review the progress and quality of the ongoing work. The Consultant will generate Field Observation Reports in the

findings of the inspection. The Consultant shall advise the BSS Contractor during the inspection of any concerns noted with respect to the installation and shall repeat the concerns in writing as soon as possible after the inspection is completed. The BSS Contractor shall take corrective action to meet the requirement of the specifications.

- .3 Failure to identify any error or omission during inspections made in the installation phase shall not relieve the Contractor of any of the specification requirements.

4.2 ACCEPTANCE TESTING

- .1 Prior to the scheduling of the acceptance testing with the Consultant, perform a complete and detailed operational check of each BSS component. Test results shall be documented using test sheets. The test sheets shall be prepared in an appropriate format for the various categories of component to be tested and shall be submitted for approval during the shop drawing phase of the project.
- .2 Completed test sheets indicating the test results for each BSS component within the system shall be submitted to the Consultant, together with a proposed schedule for acceptance testing, at least two weeks prior to the proposed acceptance testing. The Owner and Consultant shall determine on the basis of the BSS Contractor's testing, whether or not it is appropriate to commence acceptance testing. It shall be their decision as to whether the acceptance testing can proceed as proposed by the BSS Contractor or whether deficiencies have to be remedied before the acceptance testing can proceed.
- .3 The entire installation shall go through final acceptance testing at the completion of the project. Installation, engineering, software and system personnel shall be available on-site during the acceptance test. These personnel shall be familiar with the installation and shall undertake all tests as requested by the Owner and Consultant in order to verify that the BSS components individually and in total meet the specifications. The BSS Contractor shall provide wireless radios to allow communication among the testers in the field.
- .4 Deficiencies shall be indicated on a "punch-list". The deficiencies shall be corrected and a time of follow-up testing shall be scheduled. If there are deficiencies remaining after the follow-up testing that required further testing by the Consultant, then the expenses of the Owner and Consultant incurred in providing the additional follow-up tests to verify compliance with the specifications, including travel, subsistence, accommodation and normal consulting fees, shall be paid by this Contractor at no additional cost to the Owner.

4.3 TEST SHEET FORMAT

- .1 Provide ACAMS test sheets for each ACAMS monitored and controlled device. Include, at minimum, the following categories on the test sheet.
 - .1 Point number - as identified on the security drawings.
 - .2 Card reader - test using valid and invalid card.
 - .3 Electric Lock - test release upon valid card and ACAMS operator command, and non-release upon invalid card.
 - .4 Door Status - test each door leaf independently for held open door status.
 - .5 Forced door - test each door leaf independently by removing power to the electric lock (if applicable) and then opening the door.
 - .6 REX devices - test each device independently for activation status.
 - .7 Alarm devices – generate appropriate alarm condition, and test each device for alarm status (visibility, audibility, etc.).
- .2 Provide CCTV test sheets for each CCTV camera. Include, at minimum as applicable, the following

categories on the test sheet.

- .1 Point number - as identified on the security drawings.
 - .2 Image Quality - visually verify each cameras image quality.
 - .3 For coordination with the Owner/Consultant, provide preliminary test sheet displaying a colour snap shot image of the maximum field of view (FOV) for each camera in the system. Once markup drawings of the desired field of view of each camera are provided by the Owner/Consultant, point and focus the respective camera to the desired FOV for final test sheet.
 - .4 Confirmation of optimal FOV with a colour snap shot image (minimum 2" x 2") recorded on the test sheet
 - .5 Motion - test each camera independently for motion detection alarm, and that appropriate recording actions have been initiated.
- .3 Provide SIS test sheets for each intercom station. Include, at minimum as applicable, the following categories on the test sheet.
- .1 Point number - as identified on the security drawings.
 - .2 Call quality – confirm audibility and intelligibility of communication between substation and master station are sufficient to suit the location of the substation.
 - .3 Call sequencing – confirm that the ring sequences are in compliance with Section 28 26 00.

***** END OF SECTION *****

PART 1: GENERAL**1.1 WORK OF THIS SECTION**

- .1 This section details the requirements for those components of the BSS relating to BSS documentation.

1.2 RELATED REQUIREMENTS

- .1 The requirements of the Project Manual are related to and shall be read in conjunction with this section.
- .2 This section is related to and shall be read in conjunction with all other Division 28 sections.
- .3 This section is related to and shall be read in conjunction with the BSS drawings.

PART 2: REQUIREMENTS**2.1 DOCUMENTATION - GENERAL**

- .1 The primary purpose of the shop drawing and equipment documentation submittals is to give instruction and information to those responsible for providing a turnkey BSS which is compliant with the BSS specifications in all respects. The Consultant shall review the shop drawings and equipment documentation submittals with the intent of identifying as many potential areas of non-compliance as possible, but the review of shop drawings and equipment documentation submittals by the Architect, Engineer and Consultant, shall not relieve the Contractor of the responsibility for complete compliance with the specifications. Identification of some errors by the Architect, Engineer and Consultant but overlooking others does not relieve the Contractor of his responsibilities nor does it allow him to proceed based on erroneous shop drawings and equipment documentation submittals.
- .2 Approval of shop drawings or submittal data by the Architect, Engineer or Consultant shall not constitute an order to fabricate, purchase, ship to the site or undertake any other action. The sole responsibility for the timely purchase and/or fabrication of components, obtaining approval on shop drawings and equipment documentation submittals, and delivery of components to the project to comply with the requirements of the project schedule is that of the Contractor.
- .3 The intent of the record documentation is to provide the Owner with complete information on the BSS provided such that a person familiar with installations of this nature shall be able to perform any operating, maintenance or engineering functions with respect to this BSS without having to contact the BSS Contractor or obtain any additional documentation.

PART 3: PRODUCTS**3.1 SHOP DRAWING AND EQUIPMENT DOCUMENTATION**

- .1 Prepare all shop drawings, diagrams, equipment and device schedules, equipment technical data sheets and software information necessary for the Consultant to determine compliance with the specifications. Submit all shop drawings and equipment documentation data together as one submittal within four (4) weeks after notice to proceed.
- .2 The following information shall be included on the cover page for each shop drawing and equipment documentation sheets:
 - .1 Project name.
 - .2 Date.
 - .3 Submittal number and re-submittal number as appropriate.
 - .4 Name and address of Consultant.

- .5 Name and address of General Contractor.
 - .6 Name and address of BSS Contractor.
 - .7 Name and address of supplier or vendor if appropriate.
 - .8 Name of manufacturer.
 - .9 Reference to the applicable Specification Section by name and number.
 - .10 Stamped and signed coordination certification stamp.
 - .11 Compliance certification as required in Section 28 00 01.
- .3 Shop drawings shall be CAD generated and be clearly referenced to each other and shall include diagrams, mounting instructions, installation procedures, equipment details and software descriptions for all components of the system. AutoCAD floor plan drawings shall be provided to the Contractor. Shop drawings shall be in this order and at a minimum include:
- .1 Cover page with required information identified above.
 - .2 Floor plan drawings in same order and format as architectural drawings. Floor plans shall indicate each BSS field device location. Uniquely identify each cable type for each field device. Identify desired cable routing from each device to termination location. Update these drawings to reflect actual routing location on as-built submittals. Provide a chart based schedule on each floor plan drawing or on a separate drawing sheet prior to the floor plans with, at minimum, the following columns for:
 - .1 ACAMS:
 - .1 Point reference.
 - .2 Device type (card reader, door contact, local alarm, etc. with manufacturer/model number).
 - .3 Lock/control type (manufacturer/model number) if appropriate.
 - .4 Request to exit device type (manufacturer/model number) if appropriate.
 - .5 Special accessories.
 - .6 Cable type (manufacturer/model number).
 - .7 Cable colour and labelling scheme.
 - .2 CCTV system:
 - .1 Fixed or PTZ.
 - .2 Camera and Lens type (manufacturer/model number).
 - .3 Housing type (manufacturer/model number).
 - .4 Mount type (manufacturer/model number).
 - .5 Special accessories.
 - .6 Cable type (manufacturer/model number).

- .7 Cable colour and labelling scheme.
- .3 Floor plan drawings in same order and format as architectural drawings. Floor plans shall indicate each BSS field device location. Uniquely identify each cable type for each field device. Identify desired cable routing from each device to termination location. Update these drawings to reflect actual routing location on as-built submittals. Provide a chart based schedule on each floor plan drawing or on a separate drawing sheet prior to the floor plans with, at minimum, the following columns for:
 - .4 Separate wiring schematic diagram for each system. Include all types of controllers, panels, interfaces, and interconnection locations to head-end equipment.
 - .5 Separate Riser diagrams for each system including general layout and configuration of each system indicating major component locations and relationships.
 - .6 Detail installation diagrams of all monitoring and control equipment for each monitoring and control equipment location. Include routing of wiring.
 - .7 Wiring diagrams and installation drawings for each component.
 - .8 BSS data communications network architecture diagram indicating all NDS's, OIW's, SAN devices, ICP's, video encoder/decoder units, CIS's, other network connected devices, network switch and network interface connection points.
- .4 Equipment documentation submittals shall include design, performance and installation details for all aspects of the system to be installed. At minimum, the submittals shall include:
 - .1 Bill of Quantities with name and address of supplier or vendor for each device.
 - .2 Equipment technical data sheets.
 - .3 Central monitoring and control equipment.
 - .4 Operator workstation specifications and data sheets.
 - .5 Software specifications and descriptions.
 - .6 Training outline.
- .5 Literature pertaining to a particular item, piece of equipment or installation shall be submitted at one time and shall be specifically prepared for this project. Each submittal shall be properly marked with service or function, any options available that are not to be provided shall be crossed out or options that will be provided shall be highlighted.
- .6 Comply with the requirements of the Contract Documents. Any deviations from the Contract Documents will not be allowed. Submittals not in accordance with the Contract Document requirements shall be rejected. Before equipment, devices and materials are installed; they shall have submittals that are stamped "Approved" or "Approved as Noted". "Approved" or "Approved as Noted" submittals containing errors and/or omissions shall not relieve the Contractor from the requirements to comply with the complete requirements of the specifications. Corrections or modifications to the work because of errors and/or omissions shall be at the Contractors expense.
- .7 Each submittal shall be reviewed, and electronically stamped and certified by all applicable parent contractors prior to submission to the Consultant. The certification shall be in the form of a rubber stamp, which states:

I hereby certify that the equipment shown on this shop drawing, product data and or sample, complies in all respects with the requirements of the Contract Documents for this Project. I further certify that all data shown hereon as to performance, dimensions, construction, materials and other pertinent items is true and correct.

(Name of the BSS contractor)

Signed:

Position:

Date:

- .8 Submit electronic copies of all shop-drawing submittals to the Architect, Owner, Consultant, General Contractor, General Contractor Project Manager, and Electrical Sub-Contractor.
- .9 Shop drawings or equipment documentation submittals returned that are noted "Approved" on "Approved as Noted", do not require additional review.
- .10 Shop drawings or equipment documentation submittal data that are noted "Revise and Resubmit", will require additional review. Resubmit all shop drawings and equipment documentation submittals noted "Revise and Resubmit" within two weeks of receipt of the rejected shop drawing or equipment documentation submittal. If more than two reviews are required for any shop drawing or equipment documentation submittals, the Contractor shall reimburse the Owner for any additional fees and expenses required from the Architect, Engineer or Consultant in performing the additional reviews.]

PART 4: RECORD DOCUMENTATION

- .1 At minimum, the record documentation shall include all submittals (shop drawings and equipment documentation) made at the shop drawing stage up-dated to reflect the actual installation and the manuals outlined below.
- .2 A draft version of the record documentation shall be submitted to the Consultant at the time of the request for acceptance testing. Following the acceptance testing and, if necessary, the subsequent rechecking of deficiencies, the BSS Contractor shall re-submit the record documentation incorporating all changes resulting from the acceptance testing and any other changes requested by the Consultant as a result of the consultant's review of the draft version of the record documentation. The Certificate of Substantial Performance shall not be granted until the final approved record documentation has been received.
- .3 Update all documentation to indicate any changes made during the Warranty Period.
- .4 Provide record documentation in manuals as indicated below:
 - .1 Operators' Manuals (PDF format).
 - .2 Managers' Manuals (which includes the Operators' Manuals (PDF format).
 - .3 Hardware Manuals (PDF format).
 - .4 Security shop drawings (PDF format)
- .5 Provide Operators' and Managers' Manuals with, at minimum, the following information:
 - .1 Details of all features and functions available to the Operators and Managers.
 - .2 Details of all alarm, diagnostic, error and other messages. Detail the Operator action to be taken for each instance.
 - .3 Detail special programs provided and provide a complete programming instruction manual. Detail operations of all software applications.
 - .4 Detailed listing of the database for all installed devices.
 - .5 Details of all data base management functions and features.
 - .6 All details and descriptions shall be in a step-by-step format such that an Operator or Manager shall be able to respond to and undertake the respective actions on the basis of information provided in the manuals and drawings.
 - .7 Provide hardware manuals that shall include, at minimum, the following:

- .1 Details of all specifications including maintenance and installation requirements for all computers, field panels, equipment, devices, interfaces and facilities provided.
 - .2 Record drawings and schedules of the completed installation including location of devices, mounting details, and wiring details.
 - .3 Operating sequences and interlocks.
 - .4 Names and addresses of spare parts suppliers.
- .6 Record drawings shall be CAD generated, pdf printed, based on the latest version of AutoCAD and shall include, at minimum, the following:
- .1 Details required by the shop drawings.
 - .2 Final locations and point ID for each monitored and controlled device.

***** END OF SECTION *****

PART 1: GENERAL

1.1 WORK OF THIS SECTION

- .1 This section of the specifications details the requirements for the training to be provided by the BSS Contractor.

1.2 RELATED REQUIREMENTS

- .1 The requirements of the Project Manual are related to and shall be read in conjunction with this section.
- .2 This section is related to and shall be read in conjunction with all other Division 28 sections.
- .3 This section is related to and shall be read in conjunction with the BSS drawings.

PART 2: EXECUTION

2.1 TRAINING

- .1 Four weeks prior to the commencement of training, submit an email outline of the training materials and curriculum to the Owner and Consultant for review and approval. This outline shall include a schedule of the training sessions, topics to be covered in each session and any prerequisite requirements that should be met prior to attendance, including pre-class study materials, indicated as such. Training shall not commence unless a training outline and schedule has been approved by the Owner and subsequently reviewed and approved by the Consultant.
- .2 The training program shall include 8 hours training for system administrators, and 8 hours of training for client system operators. Training should be on-site on the newly commissioned systems that form part of this integrated security project.
- .3 Provide sign-in sheets for all training sessions, and provide to Owner and Consultant for sign-off on training completion.
- .4 Provide all required pre-study and training materials (hand-outs, textbooks, workbooks etc.) and also provide any computer, audiovisual, notebook, writing materials, and other equipment required to execute the training.
- .5 Training sessions shall be formatted to maximize the usage of time of the attendees and prevent redundant coverage of materials for advanced students. Training sessions shall be designed toward the specific requirements of each session based on the attendees scheduled to participate. The training shall be specific to this project and shall cover, at minimum, the following:
 - .1 Set up and implementation of all security monitoring and control software for database administrators (DBA), with demonstration of system capabilities common to DBA tasks, including but not limited to operating sequence programming, interface features, partitioning CCTV events, printing and burning event logs, and CCTV incidents.
 - .2 Login, and navigation of BSS ACAMS, SIS and CCTV systems, for system users/operators. Acknowledging incidents, writing response narratives, opening, dispatching, and closing events. Establishing door by-passes, shunting alarm points, selecting CCTV cameras for pop-up display, searching CCTV activities, re-playing CCTV events, saving CCTV files to HDD, receiving and placing communications calls, issuing SIS commands, and any other common-user activities as defined by the Owner's representative during the training précis development.
 - .3 Other subjects necessary to ensure that the operators and DBA managers will able to operate the BSS without any on-going assistance from any outside party.

***** END OF SECTION *****

PART 1: GENERAL

1.1 WORK OF THIS SECTION

- .1 This section of the specifications details the components to be provided by the BSS Contractor relating to the Access Control and Alarm Monitoring System.

1.2 RELATED REQUIREMENTS

- .1 The requirements of the Project Manual are related to and shall be read in conjunction with this section.
- .2 This section is related to and shall be read in conjunction with all other Division 28 sections.
- .3 This section is related to and shall be read in conjunction with the BSS drawings.

PART 2: REQUIREMENTS

2.1 GENERAL

- .1 The ACAMS system installed to meet the requirements of these Specifications and BSS drawings shall include all software, hardware, field devices, and other components to provide a turn-key operating ACAMS system for the Owner.
- .2 The ACAMS shall be designed in a modular fashion, such that addition and expansion to the ACAMS by adding components shall not require substantial modification of other components such as Server or Client equipment, or other ICP's and RFP's.
- .3 The ACAMS Server/Controller is existing and is off site.
- .4 The ACAMS Client work station shall serve as the monitoring component of the ACAMS. The Client software allows administrators and users to interact with the ACAMS Server/Controller, allowing for system configuration, management, and real-time monitoring of ACAMS events.
- .5 Configuration of all system components shall follow a hierarchical format, where an object which logically belongs to a higher level object is capable of inheriting the property of its "parent" object. This shall apply to, but not be limited to, partitions, logical groupings of system objects, schedules, access levels, card holders, and system users.
- .6 Each field device on the system shall be defined as active/inactive, secure/released, alarmed/suppressed as required by the function, on an as required basis via the operator, or based on a time schedule. Field devices shall be controllable individually, or as part of one or more groups.
 - .1 The system shall be capable of providing email and/or text message alerts for all alarm conditions and threats.
- .7 All equipment and materials comprising the ACAMS system shall be standard components, regularly manufactured, stocked, and utilized in the manufacturer's system.
- .8 All ACAMS components shall have been thoroughly tested and proven in actual installations.
- .9 All ACAMS components shall be provided with a minimum manufacturer warranty of one (1) year.

PART 3: PRODUCTS

3.1 APPROVED SYSTEMS MANUFACTURERS

- .1 Subject to compliance with these specifications, ACAMS equipment, software and related components as

manufactured by the following system manufacturing companies shall be considered for the work of this project:

- .1 Software House CCURE 9000 (no substitutions are permitted)

3.2 ACAMS HARDWARE

- .1 The ACAMS hardware shall be designed in a modular fashion, such that addition and expansion of an ICP shall not require substantial modification of other components, or cause downtime or operation of other ICP's.
- .2 The main hardware component is the Intelligent Control Panel (ICP). The ICP shall make and manage access control decisions with data provided by the ACAMS Server/Controller, and it shall continuously monitor and manage the communication between the ACAMS Server/Controller and Remote Field Panels (RFP's) connected to the system's inputs, outputs, and card readers.
- .3 The ICP shall be capable of managing access control and store system activity logs during loss of network connectivity. When network connectivity is re-established, the system activity logs are automatically re-synchronized with the ACAMS Server/Controller.
- .4 Failure of any ICP within the ACAMS system shall not affect the operation of the balance of the BSS systems. Failure of any ICP within the ACAMS system shall be annunciated at an OIW.
- .5 The secondary hardware component is the Remote Field Panel (RFP). The RFP shall support a combination of card readers, electronic locks, entry/exit devices, supervised inputs, relay outputs, and be connected directly to the ICP.
- .6 Each ICP shall support at a minimum the following connected devices, either directly or through a connected RFP:
 - .1 16 Wiegand card readers (including elevator cab, proximity card, proximity card + keypad, keypad, biometric, smart card, wireless, and mag-stripe readers)
 - .2 7,000 credentials
 - .3 10 card formats, up to 256 bits per card format
 - .4 64 4-state (normal, alarm, short, open) supervised inputs, including elevator functions
 - .5 64 relay outputs, including elevator functions
 - .6 1 Ethernet connection
 - .7 all access levels applicable to the ICP
 - .8 all time schedules applicable to the ICP
 - .9 all holiday schedules applicable to the ICP
 - .10 all alarm priority levels applicable to the ICP
 - .11 20,000 log events
- .7 All ICP's and RFP's shall be installed in purpose built enclosures, meeting the specifications in Sections 28 05 00 (Installations – General).
- .8 All enclosures containing ICP's and RFP's shall be equipped with tamper switches connected to the ACAMS, to annunciate at the OIW's when the enclosures are tampered with or opened without

authorization.

- .9 All ICP's and RFP's shall be powered from dedicated power supplies, which shall have sufficient battery backup to maintain all intended system operations for a period of eight (8) hours upon main power failure.
- .10 All electronic locks, card readers, annunciation and auxiliary devices which are connected to the ACAMS shall be either powered directly from the ICP or RFP, or from dedicated power supplies which shall have sufficient battery backup to maintain all intended system operations for a period of eight (8) hours upon main power failure.

PART 4: EXECUTION

4.1 SYSTEM PROGRAMMING

- .1 Programming of the database, the Contractor shall provide a proposed device naming standard to the Consultant and Owner for approval. The naming standard shall be based on the naming standard used in the Security drawings, and expanded to accommodate all the components of the ACAMS.
- .2 The Contractor shall provide the initial administration level training, as identified in the training section of these specifications, to familiarize the Owner's staff with the database structure, cardholder file information, access levels, time zones, capabilities etc. The Contractor shall develop the required time zones, access groups, access levels, the cardholder information, database definition, etc. The Contractor shall develop blank forms for all required database and cardholder information and submit them to the Owner. The Contractor shall then enter the information.

4.2 CONTROLLED DOOR/PORTAL OPERATION

- .1 Provide controlled door/portal operating sequences as required. Provide, at minimum, the following operating features:
- .2 As indicated on the electrical drawings, and where there is a ACAMS security controlled door, if the door is equipped with an automatic door operator, provide an output from the ICP and a control relay (if not supplied in the door operator) for each automatic door operator Barrier Free push-button to interrupt the signal between the pushbutton and the controller until the presentation of a valid security card.
- .3 Whenever the door is placed in a non-secure mode (i.e. time scheduled unlocked, operator override unlocked, valid entry/exit request) then the relay shall close, which will connect and complete the pathway of the signal circuit, allowing a signal from the pushbutton (if utilized) to reach the operator. Otherwise the door shall remain in a closed, but unsecured and available for Barrier Free Operation condition.

4.3 BARRIER FREE AUTOMATIC DOOR OPERATION

- .1 During automatic control by the security system, the automatic door operator shall disable (or the security system shall disable) the motion sensor located on the same side of the door as the card reader.
- .2 A valid entry request shall cause the security system to signal the automatic door operator to open the associated door. The automatic door operator shall determine when to close the door after this signal.
- .3 The motion sensor on the non-card reader side of the door shall signal the automatic door operator to open the door anytime movement is detected. The automatic door operator shall determine when to close the door after this signal.

***** END OF SECTION *****

PART 1: GENERAL

1.1 WORK OF THIS SECTION

- .1 This section of the specifications details the components to be provided by the BSS Contractor relating to the ACAMS field devices.

1.2 RELATED REQUIREMENTS

- .1 The requirements of the Project Manual are related to and shall be read in conjunction with this section.
- .2 This section is related to and shall be read in conjunction with all other Division 28 sections.
- .3 This section is related to and shall be read in conjunction with the BSS drawings.

PART 2: REQUIREMENTS

2.1 FIELD INSTALLATIONS – GENERAL

- .1 Provide, except where otherwise noted, all associated power supplies, transformers, electronic relays, terminations, cabling, panels, enclosures, housings, interconnections, and equipment required to integrate the field devices into the ACAMS.
- .2 Provide, except where otherwise noted, modifications to doorframes and doors as required for the mounting of the security field door associated devices, to provided manufacturer details, as approved by the Architect and Consultant.
- .3 Electric locks, where required by building and fire codes and except where otherwise noted, will be controlled by both the Fire Alarm System (FAS) and BSS. In these cases, the FAS subcontractor shall provide a signal indicating a fire alarm condition to each Access Control Remote Panel location as shown on the Security Drawings. The FAS subcontractor shall also provide this signal at each code-required electric lock location that has power supplies being located at the door (review electric lock description below and refer to the door hardware specifications). At each Access Control Remote Panel location:
 - .1 The BSS Contractor shall provide a terminal strip within a separate enclosure located adjacent to the electric lock power supply units.
 - .2 The BSS Contractor shall provide an interposing relay in the electric lock control circuits coming from the power supply for each door.
 - .3 The BSS Contractor shall wire between the interposing relay and the terminal strip and provide all facilities as necessary to allow a single FAS signal to unlock all electric locks.
 - .4 The FAS subcontractor shall wire to the other side of the terminal strip to provide automatic override of the electric locks.
 - .5 The BSS operation shall allow for the release of the door upon operator command or on a time scheduled basis while not impeding the automatic override release of the door by the FAS.
 - .6 The FAS shall control (unlock) all electric locking doors.
- .4 Where applicable, the power circuits powering electric locks on elevator lobby doors shall also route through the fire pull station to locally interrupt the power when the pull station is activated. The fire pull station is provided by the FAS subcontractor.
- .5 Immediately after notice to proceed is received, coordinate with the FAS subcontractor to ensure the proper hardware and interfacing noted above (and any code required interfacing) is being provided.
- .6 The BSS Security sub-contractor shall provide interfaces to any automatic – Barrier Free - door operators located on BF doors required to have electronic security ACAMS locks. BF automatic door operator

pushbuttons shall be provided by others.

- .7 The BSS Security sub-contractor shall provide a control relay (if not supplied in the BF door operator design) for each automatic door operator pushbutton such that the signal from the operator pushbutton into the controller is interrupted whenever the electric lock is engaged. Review the architectural door hardware section, architectural drawings, and electrical drawings, for automatic door operator locations.

PART 3: PRODUCTS

3.1 CARD READERS - PROXIMITY TYPE

- .1 Provide ACAMS proximity type card readers at locations indicated on the security drawings. Proximity card readers shall meet, at minimum, the following requirements:
 - .1 Manufacturers or supplier's visible identification logo or trademark is not permitted.
 - .2 Multicolour LED displaying green upon a valid read, red upon invalid read.
 - .3 Appropriate colour matching location finish.
 - .4 Environmentally protected on exterior applications.
 - .5 Contactless smart card interactive type.
 - .6 Read range of 5.0cm (2") for building applications.
 - .7 Read range of 38cm (15") for vehicle entry applications.
- .2 Installation of card readers shall meet, at minimum, the following requirements:
 - .1 Tamper resistant.
 - .2 Complete with any faceplates or trim that may be required. Provide standoff non-metallic (½ inch lexan with rounded edges) plates to prevent interference when mounted on metal walls, pedestals or building components.
 - .3 Damage by static electricity or mechanical shock is avoided. Provide grounding as required.
- .3 Provide contactless smart card technology card readers at locations indicated on the Security Drawings. Types are as follows:

Card Reader – Interior or exterior HID Signo Card Readers:

- .1 Signo 40
- .2 Signo 20

3.2 ELECTRIC LOCKS

- .1 Coordinate lock and door hardware with the general contractor and all door hardware subcontractors and review each security device location as shown on the Security Drawings to ensure the proper door hardware is provided at required locations.
- .2 Provide and terminate relay output cabling from the ACAMS ICP/RFP to the electric door locking hardware.
- .3 Specified Product: HES 1006
- .4 Parts showed above are for reference only, additional components/mounting hardware may be required.

3.3 AUTOMATIC DOOR INTERFACE

- .1 Automatic door operators shall be provided under a separate contract. Provide and terminate interface

cabling from the ACAMS ICP/RFP to the automatic door operator.

3.4 REQUEST TO EXIT DEVICE (MOTION DETECTOR)

- .1 Provide and terminate request to exit device and signal cabling from the ACAMS ICP/RFP.
- .2 Request to exit motion detectors shall be programmed not to release the electric lock upon motion detection. The request to exit shall act as an door position alarm shunt upon motion detection, in order to eliminate ACAMS alarms on a valid exit.
- .3 Specified Product: Bosch DS160
- .4 Parts showed above are for reference only, additional components/mounting hardware may be required.

3.5 AUDIBLE ALARM SOUNDER

- .1 Provide and terminate request to exit device and signal cabling from the ACAMS ICP/RFP.
- .2 Sounders shall be Rutherford Controls 903 series or equivalent.

3.6 DOOR POSITION SENSORS

- .1 Door position sensors for security doors, with the exception of below noted, shall be provided and terminated to the door connections of the Integration Enclosure door connections under a separate contract.
- .2 Provide and terminate door status monitoring cabling from the ACAMS ICP/RFP to the security connection side of the Integration Enclosure (by others).
- .3 For revolving doors, provide all conduit, cabling, and input connections from monitoring terminals of the revolving door controller to the ACAMS.
- .4 For overhead (roll up) doors, provide all conduit, cabling, and input connections from the overhead door contact to the ACAMS. Overhead door contact shall meet, at minimum, the following requirements:
 - .1 Surface mounted SPDT magnetic contact switch.
 - .2 Cable lead shall be encased in stainless steel armored cable.
 - .3 Gap reading distance of 75mm (3")
 - .4 Specified Product: GE 1078 Series
 - .5 Parts showed above are for reference only, additional components/mounting hardware may be required.

***** END OF SECTION *****

PART 1: GENERAL

1.1 WORK OF THIS SECTION

- .1 This section of the specifications details the work and components to be provided by the BSS Contractor relating to the Intrusion Detection System (IDS).

1.2 RELATED REQUIREMENTS

- .1 The requirements of the Project Manual are related to and shall be read in conjunction with this section.
- .2 This section is related to and shall be read in conjunction with all other Division 28 sections.
- .3 This section is related to and shall be read in conjunction with the BSS drawings.

PART 2: REQUIREMENTS

2.1 GENERAL

- .1 The IDS system shall be installed to meet the requirements of these Specifications and BSS drawings shall include all software, hardware, Intelligent Control Panels (ICP), Remote Field Panels (RFP), Remote Modules, field devices, sensors, and other components to provide a turn-key operating IDS system for the Owner.
- .2 The IDS shall be designed in a modular fashion, such that addition and expansion to the IDS by adding components shall not require substantial modification of other components such as other ICP's and RFP's.
- .3 The IDS shall be capable of communicating over multiple methods, including phone line, Internet, and GSM.
- .4 The IDS shall monitor and control intrusion zones, and shall perform alarm monitoring, communications loss monitoring. The system shall also maintain a database of system activity, personnel access information, system user information, user permissions, and other relevant data.
- .5 All logins, alarms, events, actions, commands, and responses shall be completed within two (2) seconds of being triggered. This shall occur across the entire IDS and its components, and shall not be affected by system activity at any given time.
- .6 The system functions shall take place in a touch screen keypad, mounted in locations shown on security drawings and documents. The keypad shall allow for monitoring, control, and alarming functions in a clearly visible, colour display.
- .7 The system shall be capable of being divided into partitions, allowing subsets of the overall system and components to be managed separately. Partitions of the system shall be capable of being assigned different access rights, and have devices zoned to specific partitions. User logins, where restricted, can only view and control partitions for which they are authorized.
- .8 Each field device on the system shall be defined as active/inactive, secure/released, armed/disarmed, alarmed/suppressed as required by the function, on an as required basis via the operator, or based on a time schedule. Field devices shall be controllable individually, or as part of one or more groups.
- .9 All devices in the IDS shall be continuously monitored and supervised, and the IDS shall be capable of detecting faults, shorts, and cuts in the connected equipment. All devices shall be supplied with end of line (EOL) resistors at the device location to supervise the connection. Installation of EOL resistors at the panel location shall not be acceptable.
- .10 All equipment and materials comprising the IDS system shall be standard components, regularly manufactured, stocked, and utilized in the manufacturer's system.

- .11 All IDS components shall have been thoroughly tested and proven in actual installations.
- .12 All IDS components shall be provided with a minimum manufacturer warranty of one (1) year.

PART 3: PRODUCTS

3.1 APPROVED SYSTEMS MANUFACTURERS

- .1 Subject to compliance with these specifications, IDS equipment, software and related components as manufactured by the following system manufacturing company shall be considered for the work of this project: DSC Neo Series
- .2 Upon completion of the installation, a floor map with the devices indicated by location shall be inputted into the C-Cure 9000. The icons for each device must appear on the site drawings, when alarms are activated. Alarms include forced open, held open all associated intrusion and access control alarms, breach on site.
- .3 Specified Product: DSC Neo Series HS2LCDRF9ENG N LCE RF keypad
- .4 Specified Product: DSC Maxsys annunciator c/w HSM2208
- .5 Parts showed above are for reference only, additional components/mounting hardware may be required.

3.2 IDS FIELD DEVICES

- .1 Subject to compliance with these specifications, IDS equipment, software and related components as manufactured by the following system manufacturing companies shall be considered for the work of this project:
- .2 Duress Button
 - .1 Proper shielded wiring shall be installed for these buttons to reliably communicate with the C Cure system.
 - .2 These duress button shall be configured as such that when activated, the button stays in a visible, activated mode until it its properly reset with a key
 - .3 Specified Product: HUB 2B latching (Desk Mounted)
 - .4 Specified Product: STI Stopper Stations SS2431E (Wall Mounted)
 - .5 Parts showed above are for reference only, additional components/mounting hardware may be required.
- .3 Duress Horn/Strobe Devices
 - .1 The horn/strobe device shall be installed throughout the interior office space, not in public spaces to alert staff that a duress has been activated. Refer to drawings for locations.
 - .2 Specified Product: Amseco – CSH24C-BW- Horn/Strobe combo BLUE
 - .3 Parts showed above are for reference only, additional components/mounting hardware may be required.
- .4 Glass Break
 - .1 Glass break detectors shall employ microcontroller-based DSP technology with wide-

band signal processing to provide accurate glass break detection of plate, laminated, wired and tempered glass, while rejecting common 'bell' or 'ringing' type sounds, and 'white noise'.

- .2 Glass break detectors shall have a built-in test mode, alarm memory (LED latching), transient/static protection.
- .3 Specified Product: Acoustic Glass Break Sensor – Sentrol 5812NT
- .4 Parts showed above are for reference only, additional components/mounting hardware may be required.

3.3 IDS HARDWARE

- .1 The IDS hardware shall be designed in a modular fashion, such that addition and expansion of an ICP shall not require substantial modification of other components, or cause downtime or operation of other ICP's.
- .2 The main hardware component is the Intelligent Control Panel (ICP). The ICP shall make and manage alarm decisions and shall continuously monitor and manage the communication between the ICP, keypads, and the connected inputs and outputs.
- .3 Failure of any ICP within the IDS system shall not affect the operation of the balance of the BSS systems.
- .4 Each ICP shall support at a minimum the following connected devices, either directly or through a connected RFP:
 - .1 Supervised inputs as required to suit the project
 - .2 1 Ethernet connection
 - .3 1 Phone line connection
 - .4 A minimum of two (2) keypads
 - .5 5000 log events
- .5 All ICP's and RFP's shall be installed in purpose built enclosures, meeting the specifications in Sections 28 05 00 (Installations – General) and 28 05 13 (Installations – Electrical).
- .6 All enclosures containing ICP's and RFP's shall be equipped with tamper switches connected to the IDS, to annunciate at the keypad when the enclosures are tampered with or opened without authorization.
- .7 All ICP's and RFP's shall be powered from dedicated power supplies, which shall have sufficient battery backup to maintain all intended system operations for a period of eight (8) hours upon mains power failure.
- .8 All inputs, annunciation, and auxiliary devices which are connected to the IDS shall be either powered directly from the ICP or RFP, or from dedicated power supplies which shall have sufficient battery backup to maintain all intended system operations for a period of eight (8) hours upon main power failure.

PART 4: EXECUTION

4.1 SYSTEM PROGRAMMING

- .1 Implement all software and provide all applicable licenses in order to provide a fully operational system. Where information is required from the Owner in order to implement the software, request such information in writing at least one (1) month prior to the need of such information.
- .2 Programming of the database, the Contractor shall provide a proposed device naming standard to the

Consultant and Owner for approval. The naming standard shall be based on the naming standard used in the Security drawings, and expanded to accommodate all the components of the IDS.

- .3 The Contractor shall provide the initial administration level training, as identified in the training section of these specifications, to familiarize the Owner's staff with the IDS capabilities.

***** END OF SECTION *****

PART 1: GENERAL

1.1 WORK OF THIS SECTION

- .1 This section of the specifications details the components to be provided by the BSS Contractor relating to the Video Surveillance System (VSS).
- .2 This section of the specifications details the components to be provided by the BSS Contractor relating to the Video Surveillance System (VSS).

1.2 RELATED REQUIREMENTS

- .1 The requirements of the Project Manual are related to and shall be read in conjunction with this section.
- .2 This section is related to and shall be read in conjunction with all other Division 28 sections.
- .3 This section is related to and shall be read in conjunction with the BSS drawings.

PART 2: REQUIREMENTS

2.1 GENERAL

- .1 Supply and install a fully functional IP based video surveillance system, including workstations, peripherals, and cameras.
- .2 The video surveillance system shall operate on a separate security network.
- .3 Provide all equipment, cameras, bezels, mounting brackets, interconnections, power supplies and other services as required to complete a fully-functional and operational VSS system as contained in the security drawings and performance specifications.
- .4 Provide setup and configuration of the video surveillance system to suit the requirements in these specifications, including alarms and actions, server, workstation and peripherals, camera number and descriptions, camera presets, camera tours, etc.
- .5 All interior ceiling dome cameras, where possible, shall be recess mounted in finished areas. Where indicated by the Architect, provide wall mount brackets with concealed wiring. Surface mounted dome cameras are acceptable in unfinished areas provided they are mounted on a finished back-box, suitable for the installation. Obtain written approval from Owner and Architect prior to finalizing design of the camera mounts in all finished spaces.
- .6 For high finish interiors, coordinate with Architect and Consultant to provide cameras with trim rings, bezels, mounts, etc. to match the surrounding finish. Submit all proposed finishes and configurations to the Architect and Consultant for approval.
- .7 VSS cameras that are required to be mounted on non-structural walls or ceilings shall be provided complete with suitable mounting plates or supporting materials on the reverse side of the wall or ceiling to ensure the devices are securely fastened.
- .8 VSS cameras shall be mounted at heights necessary to maximize the camera field of view. Housings and mounts shall be properly supported from building structure as appropriate. If required, custom mounts and housings shall be provided to allow for maximum use of the cameras. Provide any required miscellaneous materials for bracing and mounting. Conduit shall extend to the housing such that cables are not exposed.
- .9 Internet Protocol (IP) technology based cameras connected to the converged LAN for video signal transmission.

- .10 The BSS Contractor shall ensure proper equipment selection for each application. Consideration shall be given to such criteria as area of coverage, light conditions, etc., consistent with the generally accepted practices for VSS surveillance and to the approval of the Architect, Owner and Consultant.
- .11 Interior mounted fixed cameras shall be powered by LAN Power over Ethernet (PoE) Switches installed at the LAN equipment racks in the Main IT room and Telecom Rooms. Provide VSS equipment which is compliant with the IEEE Standard 802.3af. Provide all required switches.
- .12 Cameras mounted on the building exterior shall be powered by the BSS LAN Power over Ethernet Plus (PoE+) Power Supply Equipment (PSE), subject to the camera meeting the maximum PoE power requirements and the minimum ambient operating temperature requirements.

PART 3: PRODUCTS

3.1 APPROVED SYSTEMS MANUFACTURERS

- .1 Subject to compliance with these specifications, VSS system software and related components as manufactured by the following system manufacturing companies shall be considered for the work of this project.
- .2 Subject to compliance with these specifications, VSS cameras, mounts, and related components as manufactured by the following system manufacturing companies shall be considered for the work of this project:
 - .1 Axis Communications (no substitutes)
 - .1 90 degree cameras shall be Axis P3265-LVE
 - .2 180 degree cameras shall be Axis P3715-PLE
 - .3 360 degree cameras shall be Axis P3727-PLE

3.2 APPROVED VIDEO RECORDING MANUFACTURERS

- .1 Refer to City of Toronto Corporate Security document attached at the end of this specification.

3.3 VSS MOUNTS

- .1 All exterior camera mounts, metal tubes, brackets and accessories shall be of sufficient strength and diameter to defeat any detectable camera shake in up to 65 km/h (40 MPH) winds. All components and mounting bolts shall not rust or deteriorate and shall be designed for the surface to which the camera is mounted. All mounts shall allow for complete pan and tilt positioning achieving the required field of view with positive locking position bolts. Cameras mounted over heights greater than 6 meters (20 feet) shall be completely swiveled to a safe location for servicing.
- .2 Additional requirements by mount and camera type:
- .3 Hard-ceiling mounted fixed units shall not be J hook mounted.
- .4 Where electronics do not fit in camera housing coordinate imbedding an IP65 locking electronics box in base of pole or in nearest electrical ground vault. Surface boxes attached to pole are not acceptable.

VSS HOUSING

- .5 Provide VSS cameras complete with protective housings. Protective housings shall meet the following minimum requirements:
 - .1 Complete with all mounting hardware and brackets. Refer to security drawings for mount.
 - .2 Accessible, removable and lockable access doors to allow for maintenance.

- .3 Allow for the adjustment of the controls without removing the camera.
- .4 Power and signal cable harnesses and connectors to allow for the removal or replacement of a camera.
- .5 Tamper resistant.
- .6 Dome with captive shroud to conceal camera position.
- .7 Provide exterior mounted VSS cameras with housings which are non-corroding and weather proof along with integral fans, powered heating elements and controls to maintain the functional operation of the cameras and controls in the ambient temperatures specified in these contract documents.

PART 4: EXECUTION

4.1 INSTALLATIONS

- .1 Provide all required programming and complete calibration and set-up of all cameras, switching equipment, digital video recording equipment and display devices for a fully functional system.
- .2 Configure the automatic call up of cameras and their associated pre-position settings. Adjust all camera vari-focal lenses to meet the Consultant/Owners requirements.
- .3 Provide a video image snapshot showing the maximum field of view (FOV) of all installed fixed cameras complete with camera software port description. All images shall be provided to the Owner/Consultant on electronic format. The snapshot will be utilized by the Owner/Consultant to select the final desired FOV of the camera.
- .4 Create a hierarchical, interactive facility map which allows operators to manage the facility's cameras using a floor plan with interactive icons to activate live viewing, recording, and other system functions. Provide all programming necessary.
- .5 Coordinate all network configuration and installations with the building IT Services contractor. Provide all installations in compliance with the building IT Services Standards.
- .6 Coordinate IP addresses and all network configuration details with IT Services. Comply with building project IT Services requirements for IP addressing, device naming and documentation.

***** END OF SECTION *****

PART 1: GENERAL**1.1 WORK OF THIS SECTION**

- .1 This section of the specifications details the components to be provided by the BSS Contractor relating to the Security Intercom System (SIS).

1.2 RELATED REQUIREMENTS

- .1 The requirements of the Project Manual are related to and shall be read in conjunction with this section.
- .2 This section is related to and shall be read in conjunction with all other Division 28 sections.
- .3 This section is related to and shall be read in conjunction with the BSS drawings.

PART 2: REQUIREMENTS**2.1 GENERAL**

- .1 Provide a complete Security Intercom System (SIS) including all components as detailed within the BSS drawings and specifications and as required for a fully functional system.
 - .1 Installed separately from conventional general-purpose internal communications systems, the IS system shall be used as a door entry system, emergency announcement system, parking assistance system, urgent call system, public announcement system, and access control system as scheduled, indicated or required.
 - .2 The system shall be comprised of multiple IP-based control units, IP direct masters and/or door stations. Sub stations shall be installed in multiple locations as scheduled, indicated, or required for complete installation.
 - .3 A full range of control unit functions, including basic conversation, shall be capable: call forwarding, scan monitoring, emergency call, priority call, video audio recording, paging, and zone paging as scheduled, indicated or required.
 - .4 All SIS components shall utilize the BSS LAN for connectivity and transmission. All SIS stations shall be powered by Power over Ethernet (PoE) capable switches.
 - .5 Parking Assistance stations shall be installed in a purpose-built enclosure by the same manufacturer, with an integral indicator light, high visibility paint options on the enclosure, and lettering on each side of the enclosure which denotes its function. The integral indicator light shall latch on when the Parking Assistance station is activated, and may be released after the call is complete via local key switch or via the master station.
 - .6 Unless otherwise noted, Door stations shall be flush mounted with a back box, with no protrusions. Refer to security details or coordinate with Architect for elevation.
 - .7 Door stations shall be capable of releasing the associated door via the master station, either through a hardwired interface to the door lock, or through a software interface to the ACAMS.
 - .8 Provide master station at the locations shown on the BSS drawings. The dial/transfer sequence shall be coordinated with the Owner prior to programming.
- .2 The BSS Contractor shall ensure proper equipment selection for each application. Consideration shall be given to such criteria as area of noise level, environmental condition, and shall be subject to the approval of the Owner and Consultant.

PART 3: PRODUCTS**3.1 APPROVED SYSTEMS MANUFACTURERS**

- .1 Subject to compliance with these specifications, SIS equipment, software and related components as manufactured by the following system manufacturing companies shall be considered for the work of this project:
 - .1 Aiphone. No Substitutions
- .2 Master Station:
 - .1 Master stations to include direct programmable key for release of door locking hardware at door of calling substation.
 - .2 Specified Product: IX-MV7-HW – IP Video Master Station
 - .3 Parts showed above are for reference only, additional components/mounting hardware may be required.
- .3 Sub Stations
 - .1 Specified Product: IX-DV – IP Video Door Station
 - .2 Parts showed above are for reference only, additional components/mounting hardware may be required.

3.2 ANCILLARY DEVICES

- .1 System to include:
 - .1 system software and programming by manufacturer's authorized and trained technician;
 - .2 system modules, access control interface, boards, relay modules, mounting kits, flush and surface mount boxes and mounting hardware;
- .2 Ancillary devices to be of type in accordance with equipment manufacturer's requirements. Wiring to also be in accordance with applicable local governing codes and standards.

PART 4: EXECUTION

4.1 INSTALLATION

- .1 Prepare matrix of masters and substations and interconnections proposed and submit with shop drawings. Provide specified system components and connect complete.
- .2 Confirm exact type of substations with Consultant and Owner prior to ordering. Confirm station finishes, wall mounting/desk top arrangements, strobe colours, handset/hands-free arrangements and specific area applications, prior to ordering. Submit detailed shop drawings of each type of station, station features, and location of installation. Provide drawing identifying system layout and connected stations.
- .3 Install equipment enclosures in accordance with manufacturer's specifications ensuring that proper installation techniques are observed. Brackets, pedestals, and fixed in place housings to be mechanically fastened to building structure independent of other support systems. Under no circumstances are enclosures be fastened to suspended ceiling support systems. Exact enclosure type to suit installation location, and such location to be confirmed with Consultant prior to roughing-in. Enclosures to be permanently tagged with identification properly noted and cross-referenced on "As Built" drawings.
- .4 Install devices in accordance with system manufacturer's instructions.
- .5 Include for and arrange for system manufacturers authorized representative to program system. Provide servers in locations as required to provide best system performance as per manufacturer's recommendations.
- .6 Backbone of the system to be IP based Ethernet LAN network structured cabling infrastructure based on requirements as specified in Communications drawings and specifications. System network to include use of fibre optic cabling, UTP copper horizontal network cabling and components, and network switches. System integrator to coordinate with the telecommunications system integrator responsible for the IT network structured cabling system, and provide network cabling structure to serve the intercom system,

consisting of but not limited to providing the following:

- .1 system components to match requirements of other Sections;
- .2 dedicated enclosed equipment racks for mounting of required network switches, patch panels and UPS unit;
- .3 dedicated system of fibre optic cabling and horizontal UTP copper cabling and jacks;
- .7 Confirm and coordinate exact requirements with system supplier. Electrical provisions (conduits and wiring) shown on drawings are assumptions and are only to be used for pricing purposes. Include for power transformers as required and installed to suit specific applications.
- .8 Verify with system vendor, exact power, control, communications, and conduit requirements for specific system(s) being installed. Coordinate requirements with shop drawing submissions. Be present for system testing and make any necessary power or control wiring revisions.
- .9 Installed cabling, connectors and equipment to meet or exceed minimum manufacturer specifications. Any cabling, connectors or equipment failing to meet those specifications to be promptly replaced at no additional cost to Contract. In finished areas, run conductors and conduits concealed.
- .10 Cable and equipment installation to be permanently tagged with identification properly noted and cross-referenced on "As Built" drawings to be provided to Consultant, upon completion, verification, and acceptance of installed systems.
- .11 Verify with Consultant, exact installation height of devices, prior to roughing in. Wall mounted units typically to be recessed mounted. Provide suitable back box. Coordinate installation with Consultant and trades responsible for wall construction.
- .12 Provide integration per the General Requirements and other Division 28 specifications. Confirm integrations and exact sequence of calling with Consultant and Owner prior to start of Work.
- .13 Confirm station finishes and colours, identification nameplates and nomenclature with Consultant prior to ordering.
- .14 Ground and bond system to code and manufacturer's requirements.
- .15 After installation work is complete, coordinate with and work with system vendor to test, adjust, and certify operation of system.

***** END OF SECTION *****

1.0 Scope of Work and Associated Deliverables

- 1.1 The Successful Bidder shall provide Project Management, design and coordination of all Work on the systems within this contract, and maintain all required communications between various City of Toronto divisions and third party service providers.
- 1.2 The Successful Bidder shall be the single point of contact and shall be responsible for all coordination of Work that pertains to the Systems, along with all required coordination and communications between Personnel and the City.
- 1.3 The Successful Bidder shall be in good standing with all manufacturers referenced in this RFQ (including but not limited to American Dynamics, Dedicated Micros, Milestones and Axis) and must have and maintain all up to date certifications.

2.0 Literature

Bidders, where applicable, should submit complete literature on all products being included in their quotation including, but not limited to, standard manufacturer's warranty, model numbers, part numbers and other relevant documentation as part of their Quotation.

3.0 Bidder Qualifications

- 3.1 Bidders must be authorized sellers or resellers for the Products listed section 33.0 Manufactures List and must hold title to any equipment that will be installed or removed. If requested by the City, Bidders must submit written verification of current and valid authorization, satisfactory to the City, prior to Award. Failure to submit written verification of authorization, satisfactory to the City within a time frame specified by the City will result in the Quotation being declared Non-Compliant.
- 3.2 Prior to award, if requested by the City, the Bidder must submit written verification that their technicians are certified and authorized to undertake the installation and delivery services described in this RFQ. Failure to submit written verification of certification/authorization satisfactory to the City within a timeframe specified by the City will result in the Quotation being declared Non-Compliant.

Bidders must provide within five (5) business days of such a request, a copy of each person's resume and certifications for proof of meeting the requirements listed in each Mandatory Criteria. Failure to provide this information within the timeframe specified, will result in non-compliance and the Bidder's Quotation will not be considered further.
- 3.3 All Certificates must be valid at the time of submission and throughout the duration of this contract.

3.4 Mandatory Criteria 1:

- Bidders must maintain personnel with the minimum years' experience Personnel as indicated that meet the mandatory criteria in Table 1 below:

Table 1

Item Number	Years of Experience	Certification and or Training on the following systems
CCTV		
1.1	3	Milestone Certified Design Engineer
1.2	3	Milestone Certified Integration Technician
1.3	3	BriefCam
	3	Victor and VideoEdge Advance Installer
DSC		
1.4	3	Power Series 1864 System
1.5	3	DSC Power Neo Alarm Panels
ACS		
1.6	3	Visonic – PowerMaster 10/30
1.7	3	Key Tracer
1.8	3	Software House - CCURE 9000 Level 2

- During the Term of the Contract, the Successful Bidder may substitute Personnel due to staff changes with Personnel of equal or greater qualifications and experience. Any change of Personnel shall be approved by the City prior to the substitution taking place.

3.4.0 All systems components and installation shall conform to the following standards and codes where appropriate:

- Manufacturing: ISO 9003
- Design: MIL 275E
- Communications: IEEE RS232C and RS485
- EMI emissions: FCC part 15
- Electrostatic immunity: IEC 801.2 level 4
- AC transients UL 964
- National Building Code
- Ontario Fire Code
- Electrical Standards Authority
- Process Control System Implementation Manual
- NFPA 730 & 731
- ULC 319/S304
- UL 1981 Central Station Automation System
- UL 681 Installation and Classification of Burglar and Hold up Alarm Systems
- UL1635 Digital Alarm Communicator System Units

4.0 Security Clearance Requirements

- 4.1 A Clearance Letter from Toronto Police Service is a formal document produced on secure paper indicating that the subject of the inquiry has no criminal convictions in the National Repository of Criminal Records, which is maintained by the RCMP. The Successful Bidder shall provide within fifteen (15) business days after contract award to the Project Manager, a Police "Clearance Letter", obtained within the past three (3) months for each person (including Subcontractors), that may be expected and/or will be performing Work under this contract.
- 4.2 The Successful Bidder's employees (including Subcontractors) that may be expected and/or will be performing Work under this contract shall not pose a foreseeable security concern or hazard to the City as it relates to the protection of its assets.
- 4.3 Unless authorized in writing by the Project Manager, only Personnel that provided a Clearance Letter to the Project Manager shall be permitted to Work under this contract.
- 4.4 The Successful Bidder shall provide an original recent (obtained within the past 3 months) Clearance Letter only. No copies will be accepted.
- 4.5 The cost for each of the Clearance Letters shall be the complete responsibility of the Successful Bidder.
- 4.6 Refer to the Supplementary Forms and Policies section

5.0 Specifications

5.1 Meeting

- 5.1.0 A kick-off meeting will be scheduled by the Project Manager with the Successful Bidder upon award to review the roles and responsibilities of the City and the Successful Bidder.
- 5.1.1 The Successful Bidder and their qualified Personnel (including Subcontractors) assigned to this contract shall attend the kick-off meeting if requested by the Project Manager.
- 5.1.2 The Successful Bidder's Project Coordinator (or designate) shall be responsible to coordinate, plan and schedule as many subsequent meetings as necessary throughout the Term of the contract to ensure effective project stakeholder communication.
- 5.1.3 All meetings shall be held within the City of Toronto. The Successful Bidder is responsible for all costs for consultation and project/subsequent meetings.

- 5.1.4 The City reserves the right to request subsequent meetings on-demand or on short notice and may change or cancel meetings at the discretion of the Project Manager and at no cost to the City.

5.2 Resource Commitments

- 5.2.0 The Successful Bidder is the Design/Builder on Record and must continue to meet all of the requirements of Systems certifications and qualifications with respect to training and staffing competency, at the sole expense of the Successful Bidder, throughout the Term of the Contract, for all of the systems and components installed and in use at the facilities.
- 5.2.1 The Successful Bidder must continue to meet all of the mandatory conditions of the Warranty throughout the Term of the contract and Warranty periods.
- 5.2.2 The Successful Bidder must be able to provide the necessary materials, tools, machinery and supplies to carry out all approved Work. These resources must be available at the sole responsibility of the Successful Bidder on a dedicated basis throughout the term of the contract, to coordinate and carry out all approved Work with due care, skill and efficiency. The City may request removal and replacement within five (5) calendar days of any Contract Leads at any time throughout the duration of the contract.
- 5.2.3 The Successful Bidder must guarantee to the City that their Services and performance, including those of the Subcontractor, shall be provided in a professional, good, workmanlike manner and comply with, but not be limited to the City's City-Wide Security Policy, Workplace Violence Policy and the City of Toronto's Security Video Surveillance Policy. Those deemed not complying, at the discretion of the City, will be removed from the site and all future projects for the duration of this contract. The Successful Bidder will be provided three (3) notices of non-compliance and then be in breach of this contract, which may include contract termination as per the City of Toronto policy and guidelines.
- 5.2.4 Only Personnel listed and registered with the City will be permitted to access and Work on City of Toronto sites.

5.3 Cleaning

- 5.3.0 The Successful Bidder must maintain the worksite, grounds, and building free from accumulations of waste material and rubbish, and provide on-site containers for collection of waste materials and rubbish as required. On site storage areas must be coordinated through and arranged by the City. Cleaning and disposal operations must comply with local ordinances and anti-pollution laws.

- 5.3.1 The Successful Bidder must clean dust and water residue from core drilling, cutting and patching of masonry, and drywall to satisfaction of the City. Furnishings, floors and finishes must be protected prior to the commencement of Work.
- 5.3.2 Promptly as Work proceeds, and upon completion, the Successful Bidder and each of its Subcontractors shall clean up and remove from the premises all rubbish, dirt, dust, debris and surplus materials resulting from the Work.
- 5.3.3 The Successful Bidder must at all times be considerate of site security and ensure all worksites are maintained accordingly.

5.4 Cosmetics, Protection, and Finishes

- 5.4.0 The same tamper proof screws and fasteners shall be used on all equipment, enclosures, cabinets and materials in public areas. Corporate Security shall be provided two sets of tools (at no charge) which are required to service security equipment that have tamper proof screws and fasteners.
- 5.4.1 Finishes and graphics for all equipment in public areas shall be submitted to, and approved by the City.
- 5.4.2 The Successful Bidder shall be responsible for all cutting, core drilling, and patching required for the installation of this Work. Where alterations occur or new and existing Work is required, the Successful Bidder shall join, cut, remove, patch, repair, or finish the adjacent surfaces as required to meet same or better quality at no extra costs to the City.
- 5.4.3 Any Work likely to alter or detract from the original appearance must not commence without the City's written consent. Changes or alterations, completed without the City's consent, may be subject to restoration by the Successful Bidder. Any additional repairs required, due to unapproved Work, may be billed to the Successful Bidder for payment.
- 5.4.4 The Successful Bidder shall protect existing furnishings by providing and maintaining adequate temporary protective coverings.
- 5.4.5 The Successful Bidder shall provide and maintain adequate fire safety in accordance with applicable fire code and Regulations.
- 5.4.6 The Successful Bidder shall be responsible for any damage to existing structure or contents arising from a lack of adequate protection.
- 5.4.7 All Work shall be performed by a qualified and skilled trade's people as defined by the Occupational Health and Safety Act, Regulation 213/91 and all finishing shall be of the highest

quality. Construction and finishing techniques must preserve the original appearance of the affected areas.

- 5.4.8 Unless authorized in writing by the City, the Successful Bidder shall not post/affix any stickers, labels, signs, logos, or any kind of promotional or advertising material on any equipment or instruments, nor at any City of Toronto site. This includes decals warning of systems in use or Services provided.
- 5.4.9 All materials, accessories, special equipment, services, personnel, test equipment and tools required for installation of the equipment shall be provided by the Successful Bidder.

5.5 Codes, Permits, Fees and Inspection

- 5.5.0 All system components shall be installed according to manufacturer's instructions and in a professional manner. Workmanship and care must encompass all aspects of the task being performed so the full intent of the project may be realized.
- 5.5.1 All Work shall be performed in compliance with all applicable Regulations, Building Codes and Local By-laws.
- 5.5.2 The Successful Bidder shall be responsible for all work and material including, but not limited to surveying, scanning, soil sampling, stamped engineered drawings, cutting, core drilling, patching, trenching, excavating, temporary storage of material, laying of conduits and backfilling for the installation of assigned Work.
- 5.5.3 The Successful Bidder shall arrange for inspection of all Work by the authorities having jurisdiction over the Work. The Successful Bidder shall comply with the requirements of the authorities, federal, provincial and municipal Codes, and all other authorities having jurisdiction. These Codes and Regulations constitute an integral part of these specifications. In case of conflict, the applicable Code takes precedence over the RFQ document.
- 5.5.4 All Work shall be executed to the approval of the City. When the Work is reported to be complete, an inspection shall be made by the City, and all deficiencies found shall be corrected by the Successful Bidder within 30 calendar days of reporting the deficiency, and before the final payment is made.
- 5.5.5 The City may appoint and pay for an independent consultant to inspect the Work or to carry out specific tests as the Work progresses. The Successful Bidder shall notify the City and the consultant at least three calendar days prior to starting the Work, and shall provide any assistance that the consultant may require to carry out his/her inspections or tests at no additional cost to the City.

- 5.5.6 The consultant, if any, shall act on behalf of the City to ensure that the performance of the Work is carried out according to the specification, drawings and acceptable standard practice. The Successful Bidder shall co-operate with the consultant and shall comply with his/her directions in making good all deficiencies and defects, and in ensuring the proper execution of the Work.
- 5.5.7 The verification or acceptance of the Work by the consultant or the City does not relieve the Successful Bidder of his/her responsibility to comply with the specifications. Any Work subsequently discovered, which does not comply with the specifications shall be rectified by the Successful Bidder at no cost to the City.

5.6 Daily Check In/Out

- 5.6.0 Before Work commences, the Successful Bidder shall have already incorporated all site and facility constraints as it relates to on site access time and Work performance limitations.
- 5.6.1 Before commencing Work and prior to completion of any Work, the Successful Bidder's Personnel must check-in and out daily with the City of Toronto Security Control Centre at 416-397-0000, and if available with on-site Security.
- 5.6.2 Upon check-in and check-out, the Successful Bidder's Personnel shall clearly explain what effects their Work will have on current security systems or VSS that are being monitored, and they shall identify any anticipated alarm signals, as well as any system functional limitations.

5.7 Disruptions to City Operations

- 5.7.0 Careful consideration must be given at all times to the function of the facility and the persons contained. The Successful Bidder must make all attempts to cause as little disruption in service as possible when providing installation services. Work that may cause any type of major disruption to building operations and/or building occupants must first be cleared by the City, and may have to be completed after hours.
- 5.7.1 The Successful Bidder shall co-ordinate all Work with the City's representative to ensure minimum disruption of service.
- 5.7.2 Work shall be executed to minimize the impact or the disruption of the existing operational systems and City of Toronto facility operations. At any time during the performance of the Work, if the existing, operational systems are affected beyond the expectation approved through the Implementation Plan or there is an imminent danger to be affected beyond the approved expectation, the Successful Bidder shall stop Work and minimize the impact on the operational systems. The Successful Bidder shall immediately inform a City of Toronto Corporate Security representative. The Successful Bidder shall perform all Work to implement a temporary solution to enable 100% functionality for operational systems. The Successful Bidder is to

proceed with permanent Work only after a solution is approved by City of Toronto Corporate Security.

5.8 Impact on City of Toronto Operations

- 5.8.0 Operational restrictions may affect the scheduling of Work and may require some activities to be scheduled at night, during weekends, or during periods when facilities are not inservice.
- 5.8.1 The Successful Bidder shall perform the Work in a manner to prevent disruption of normalCity of Toronto operations. Any task that may cause disruption of operations shall be approved in advance by City of Toronto Corporate Security.

5.9 Inspection of Work

- 5.9.0 City of Toronto Corporate Security reserves the right to inspect any and all Work and reserves the right to be present during the performance of any Work under this Contract.
- 5.9.1 City of Toronto Corporate Security will perform periodical and statistical inspections of the Work. The Successful Bidder shall provide and facilitate access to Work for inspection.
- 5.9.2 The Successful Bidder shall correct within a maximum of one week (7 calendar days) any Work deemed not satisfactory by the City of Toronto.
- 5.9.3 In the event that the Successful Bidder does not correct the Work within the time frame specified, the City reserves the right to have the Work completed by another qualified firm at the Successful Bidders expense.

5.10 Occupancy Before Completion

The City may use portions of the Work although the same may not be entirely complete without claim of any kind by the Successful Bidder so doing, nor shall any such use relieve the Successful bidder from his/her obligation under this contract until the termination of the guarantee/Warranty period.

5.11 Monitoring/Programming

Many of the inspected devices require confirmation of device annunciation on the monitoring screen. Personnel must arrange/coordinate with the Corporate Security Lead to change a given device's armed, controlled or online status. Personnel must ensure the previous state is restored upon completion of the inspection testing.

5.12 Equipment, Placement, Relocation, Removal, or Expansion

- 5.12.0 Some existing hardware may require removal or relocation for installation of new devices. In each instance, the Successful Bidder must advise Corporate Security, and the Successful Bidder must receive written approval prior to the removal or relocation. All costs associated with the removal or relocation are the sole responsibility of the Successful Bidder.
- 5.12.1 All placements of security devices are subject to approval by Corporate Security before final acceptance is granted.
- 5.12.2 All equipment and devices, removed by the Successful Bidder for replacement or placement of a new security device, shall remain the property of the City and shall be submitted to the City upon device removal.

5.13 Design and Installation

- 5.13.0 The Successful Bidder is responsible to provide a fully functional system meeting the City's standards as required by this RFQ.
- 5.13.1 The Successful Bidder shall be the design builder required to supply and/or install fully functional integrated, Security System for the City of Toronto. The Successful Bidder shall be solely responsible for its design errors or omissions. Including, but not limited to situations where all the necessary materials to deliver a fully functional integrated CCTV and AV system have been missed. This clause shall not apply where the City requests a change to the original design request. The Successful Bidder shall be solely responsible for detailed design, project management, coordination, equipment procurement, installation, component wiring, terminations, connections, labelling, programming, integration, testing, commissioning and as-built drawings of all Systems.
- 5.13.2 The Successful Bidder shall supply and/or install all required Systems electronic equipment, hardware, software, licenses and connections, to allow for City required functionality under this RFQ.
- 5.13.3 The systems shall consist of field, infrastructure, and monitoring devices integrated to the access control and intercom systems necessary to provide a fully automated system to control authorized traffic in and out of controlled areas of City facilities.
- 5.13.4 The system shall be designed on a distributed processing architecture employing remote DGPs (Data Gathering Points) and operator workstations connected through TCP/IP and/or serial communication protocols, where applicable.

- 5.13.5 As part of this RFQ the Successful Bidder shall connect all devices to centrally located patch Panels and/or equipment located in communication rooms and /or DGP as detailed in the specification drawings and standards.
- 5.13.6 Connectivity from the IP equipment shall be based on Ethernet IP based protocols over a City supplied network, which shall connect and be programmed to servers and remote client workstations.
- 5.13.7 The Successful Bidder shall provide all programming data required to achieve the specified functionality (this includes situations where existing technology is being replaced with new technology). Such programming shall include (but is not limited to) programming of all alarms, events, triggers, timers, objects transmitting and receiving signals and interfaces as well as programming of signal receiving centre equipment to provide 100% full functionality.
- 5.13.8 Any required expansion boards/nodes and ancillary equipment needed for a full operation of the system are the responsibility of the Successful Bidder.
- 5.13.9 The Successful Bidder shall provide power supplies with battery back-up to meet NFPA 731 standards for all Systems. Failure to meet the standard will result in the Successful Bidder providing all supplies necessary at no additional cost to the City.
- 5.13.10 The Successful Bidder shall be required to populate all items such as parts and equipment from supply and install projects into a City supplied Microsoft Office database file. Upon review and approval by the City, these database files will be imported into the City central physical asset and material management database.
- 5.13.11 The Successful Bidder is responsible for all final wiring and terminations of all Systems.
- 5.13.12 The Successful Bidder shall be responsible for ensuring all structured cabling and electrical including back boxes, cabling, conduit, troughs and raceways meet equipment electrical and wiring requirements throughout all phases of the project.
- 5.13.13 The Successful Bidder shall inspect conduit, cabling, back boxes, junction boxes associated with the Systems during installation and shall notify the City Project Manager of any issues found.
- 5.13.14 The Successful Bidder shall maintain integration to existing security systems to the maximum level supported by the systems manufacturers.
- 5.13.15 Test and commission according to the 32.0 Compliance with Standards.
- 5.13.16 The Successful Bidder shall review the current site conditions and existing system configurations.

- 5.13.17 The Successful Bidder shall provide at all times sufficient competent labour, materials, and equipment to properly carry on its Work and ensure completion of each part in accordance with the Work schedule and within the contractual time period.
- 5.13.18 All installation materials, accessories and special equipment, Services, Personnel, test equipment and tools required for installation of the equipment shall be provided by the Successful Bidder.
- 5.13.19 Equipment shall be installed as per the manufacturer's recommendations, programmed and integrated to City Standards and the City Project Manager.
- 5.13.20 The Successful Bidder shall secure and be responsible for the safe keeping and protection of the system equipment until the system is fully accepted by the City of Toronto after the commissioning process.
- 5.13.21 The Successful Bidder shall coordinate all network provisioning with City of Toronto ITServices.
- 5.13.22 The Successful Bidder shall start to warrant the Systems, warranty start date, when all deliverables such as as-builts of the project have been accepted by the City and deficiencies corrected.
- 5.13.23 The Successful Bidder shall maintain the System in compliance with manufacturer's specified Preventative Maintenance schedule during the project installation period.
- 5.13.24 The Successful Bidder is responsible for all System decommissioning and removal of equipment in this RFQ, at no additional cost to the City. Including all cable removal as per ESA requirements.
- 5.13.25 The Successful Bidder shall be responsible to investigate, design and integrate to new and existing Systems.
- 5.13.26 It is the responsibility of Successful Bidder to design and finalize the System wiring diagrams, drawings, documentation and schedules in order to meet site specific conditions and provide a fully functional system.
- 5.13.27 Integration and Analytic programming for items not listed in the contract are to be shown as separate line items in quote indicating the type of integration and/or analytic to be achieved and used for the remainder of the contract term.

7.0 Supply and Installation Project Submission Requirements

- 7.1 The Successful Bidder shall (at no additional charge) submit to the Project Manager one (1) set of electronic copies of the following: project quotation, detailed project schedule, shop drawings, as-builts, warranty, and any other related supporting documents as detailed in this RFQ.
- 7.2 All electronic documents submitted to COT must be named by purchase order, site name, document type, date, and Service Request Portal Number.
- 7.3 As directed by Toronto City Council in 2005 under the City's Waste Diversion Plan, where feasible and appropriate, all hardcopy prints will be double sided. Therefore the Successful Bidder will be required to comply with this plan as it relates to all hardcopy print contract documents.

8.0 Detailed Project Schedule

- 8.1 Detailed Project Schedules are to be free from error and submitted.
- 8.2 The detailed project schedule shall include, but not be limited to the following information:
 - Commencement date for each major activity;
 - The duration of each activity;
 - The proposed sequence of activities;
 - Dependencies between internal activities and milestone;
 - Dependencies between external activities and milestone; and,
- 8.3 The schedule shall be progressively updated as the project progresses, which enables the Project Manager to readily identify activities by location and resources.
- 8.4 The schedule information shall be sufficiently detailed to enable integration of all interface activities by the Project Manager.
- 8.5 The schedule shall be presented in daily segments and shall include the following at a minimum:
 - Site surveys (as required);
 - Service Request Portal Number;
 - Submission and approval of Shop drawings;
 - Shipping confirmation date;
 - Material delivery and installation;
 - Conduit and wire pulls completed;
 - Progress photographs (only of concealed work);
 - Panels and power supplies installed and programmed;
 - Field equipment terminated, mounted and tested;
 - Security testing complete;
 - Acceptance testing complete;
 - As-built documents;

- Equipment integration and dry-run;
- Monitoring period (minimum one week);
- Commissioning and hand-over.

8.6 The schedule shall be clearly identified with the following:

- Site name, if applicable and address;
- CRO number;
- Start date of the project with time;
- Project Coordinator name with detailed contact information; and,
- Subcontractor name; and
- Project completion date.

8.7 Distribute copies of any revised schedule to:

- Project Manager; and,
- Security Project Lead
- Other Stakeholders as indicated by the Project Manager.

8.8 The Successful Bidder shall be responsible for any delay in the progress of the Work, and it being understood that no such delay shall be an "Excusable Delay" for the purposes of extending the time for performance for the Work or entitling the Successful Bidder to additional compensation. The Successful Bidder shall take all necessary steps to avoid delay in the final completion of the Work without additional cost to the City of Toronto. The City shall not be responsible for any expense or liability resulting from any such delay.

9.0 Shop Drawings

9.1 Shop drawings prepared are to be free from error and submitted in electronic format. Shop drawings are to include all items quoted with no substitutions without the prior consent of the City Project Manager. All documents produced shall be the property of the City of Toronto and the Successful Bidder shall have no rights over the entire documentation package or any parts of the documentation package.

9.2 Shop Drawings shall include:

- Date and revision number;
- Project title and number;
- Service Request Portal Number;
- Contract Drawing / Specification Reference;
- Name and address of:
 - Subcontractor;

- Supplier, Manufacturer; and,
- Wiring diagrams for each location (including distances);
- Details of types of wire and conduit type and sizes;
- Particular model number of hardware;
- Dedicated circuit in electrical panel to be used (for new installations);
- Progress photographs (only of areas with concealed work);
- Panels and power supplies (location to be installed);
- Field equipment (location of mounting);
- All device programming names;
- Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.

9.3 The Project Manager may change any drawing to remove, add or relocate any device. The Successful Bidder shall make any changes in the shop drawings, which the Project Manager may require consistent with the Contract Documents and resubmit unless otherwise directed by the Project Manager. The Successful Bidder shall notify the Project Manager in writing of any revisions other than those requested by the Project Manager and are subject to approval by the City Project Manager.

10.0 Project Commencement

10.1 Prior to the commencement of installation the successful bidder will submit the following:

10.1.0 The Security Contractor shall submit to the Corporate Security Lead the required Active and Passive network equipment specifications for all locations in scope

10.1.1 The specifications and active network equipment shall be in compliance with the City Networking standard and based on Cisco active networking equipment.

10.1.2 The Security Contractor shall submit a network communication and bandwidth flow chart for the proposed system this shall include communication steps between the various VSS components operating in normal and failover modes and their respective estimated network bandwidth requirements

10.2 Near project closeout and before project site acceptance testing the security contractor shall submit the following draft documentation in electronic form to the COT Project Manager:

- Draft test results of device and components installed
- Draft test result of cable inspection, testing and verification
- Draft schedule of all installed and/or configured devices listing as a minimum the following (Network configuration, Switch & port connectivity, location, Name/labeling, Serial Number, Warranty Start & Expiry date, Device Username/Passwords, Device IP and MAC Address, Function, etc....) in editable MS Excel format

11.0 As-Built Documentation

- 11.1 Upon successful completion and acceptance of each security project, the Successful Bidder shall submit one (1) electronic set of record documentation and drawings to City of Toronto Corporate Security within ten (10) calendar days from the date of acceptance.
- 11.2 As-built shall include drawings and shall be in the FORM of black line set, record drawings on AutoCAD 2005, as well as a .pdf version, and are to be provided on a clean CD-ROM, DVD, or via e-mail.
- 11.3 Drawings shall include:
- Shop drawing submittals;
 - Wiring diagrams for each location (include distances);
 - Details of types of wire and conduit (include type and size);
 - Particular model number of hardware (to match Summary of Security Devices Table to be provided by COT);
 - Approval of drawing submittals;
 - Beneficial occupancy date;
 - Project Completion date;
 - Equipment manufactures;
 - Factory Acceptance Tests;
 - Installation procedure;
 - O&M manuals; and,
 - Manufacturer's specification sheet.
- 11.4 Architectural: site plans, building plans, and floor plans showing all locations for every security device both new as well as any effected existing device.
- 11.5 All security devices depicted in the drawings must be individually labelled according to the programming on the security system to ensure tagging consistency.
- 11.6 All security device symbols depicted must be in conformance to the Security Industry Association Architectural Graphic Standards for Security System Layout SIA/IAPSC AG-01-1995.12(R2000.03).
- 11.7 A Summary of Security Devices Table, as installed in Excel format. The table shall include the following for each security device: Security Device CAD Symbol, Make, Model, Serial number, IP Address, MAC address, Device Type/Function, Install Date, Installing Company, network configuration, Switch & port connectivity, VLAN, location, Name/labeling, Serial Number, Warranty Start & Expiry date and a photograph of each installed device. A template will be provided by the COT.
- 11.8 Wiring diagrams and/or schedules for each system defining the interconnection of all inputs and outputs for all equipment/security devices/electrical connections including description of location and/or name of each device.

- 11.9 Construction Typical for all security applications.
 - 11.9.0 As-built shall include all information required in the prefabrication submittals revised to reflect "as installed" conditions.
 - 11.9.1 As-built shall also include one (1) sets of complete and current operation and Maintenance manuals for all devices and equipment.
 - 11.9.2 The Successful Bidder is solely responsible to include engineered stamped drawings when required by the City.
 - 11.9.3 As-builts may not have any written notes on them all entries must be electronic.

12.0 Installation Standards and Requirements

- 12.1 All direction for scope of work must be provided by the COT Project Manager. Any work completed without approval of the COT Project Manager may have to be altered at the COT request and without additional cost to the COT.
- 12.2 The Successful Bidder must deliver the specified Products and/or Services as per their Quotation without substitution or deviation.
- 12.3 The Successful Bidder shall be solely responsible for detailed design, project management, coordination, equipment procurement, installation, component wiring, terminations, connections, labelling, programming, integration, testing, commissioning and issuing of required documentation of City systems.
- 12.4 The Successful Bidder shall restore all property temporarily removed, damaged, or destroyed during the supply, delivery, and installation, of Products to the satisfaction of the City and at no cost to the City. The Successful Bidder, before final payment, shall remove all surplus materials and any debris of every nature resulting from its operation and put the site(s) in a neat, orderly condition; thoroughly clean. If the Successful Bidder fails to clean up at the completion of the supply, delivery, and installation of the Products, then the City may do so and charge the Successful Bidder for the costs thereof, or deduct said costs from any monies still owing to the Successful Bidder.
- 12.5 The Successful Bidder shall furnish all labour, materials, services, special equipment, supplies, tools, equipment, testing equipment, apparatus, trade tools, transportation, facilities and incidentals required and perform all operations necessary to accomplish the complete installation of the Product(s).
- 12.6 The Successful Bidder is responsible for all final wiring, integration and terminations of all systems.
- 12.7 Testing and commissioning is to be performance according to City and NFPA standards. Specific documentation to achieve this will be developed with the successful bidder and final template approved by City of Toronto (COT).

- 12.8 Unless authorised by the Project Manager, the Successful Bidder must flush mount all devices. Back boxes / junction boxes, all devices, equipment and components installed must be equipped with tamper resistant screws/fasteners.
- 12.9 Any back boxes / junction boxes must be installed on secure side (if applicable).
- 12.10 The Successful Bidder must ensure the electronic door operators are integrated with the access control system, and only activate when a valid card is presented. If not included during the quotation process, all associated costs will be at the Successful Bidders expense.
- 12.11 The Successful Bidder will ensure programming for any CCure systems is completed to Standard and report to maintenance mode Journal for a minimum of one week after successful site testing and deficiency correction. After one week, should no deficiencies exist, the Successful Bidder will remove the system from Journal and fully activate at the request of the City Corporate Security Lead.
- 12.12 All card readers must be ordered and programmed to City Standard/format and as directed by the City Corporate Security Lead.
- 12.13 All exit buttons are to be green in colour and embossed with the label "EXIT", no other type will be accepted even if quoted. Any errors will result in replacement by the Successful Bidder at no additional cost to the City.
- 12.14 All intercoms are to have a red button with red led status indicator that is used to communicate, no other type will be accepted even if quoted. Any errors will result in replacement by the Successful Bidder at no additional cost to the City.
- 12.15 Each facility covered under this contract shall be handed over to the City by the Successful Bidder as a turnkey operation.
- 12.16 Any power supplies, or other parts that are required shall be supplied by the Successful Bidder and shall be included in the quoted price. Power supplies must operate all connected hardware in all conditions.
- 12.17 The Successful Bidder shall be responsible for provisions of power, if it should not be present at a location. Dedicated power circuits shall be installed for each new device that will be installed as part of this project.
- 12.18 Any required expansion boards, ancillary equipment, needed for a full operation of the system are the responsibility of the Successful Bidder and must be included in the quote. Should they not be included but be required to operate the system then it will be the successful bidders responsibility to provide without cost to the City.
- 12.19 All device conditions and alarms shall be individually enunciated on the relevant system, as required for each specific project scope.

- 12.20 The Successful Bidder shall be responsible for the installation of all the equipment, units, and sub-systems, at all sites in order to meet all requirements specified in this document, as per all applicable standards, and as per manufacturer's intent.
- 12.21 All installation materials, accessories and special equipment, Services, Personnel, test equipment and tools required for installation of the equipment shall be provided by the Successful Bidder.
- 12.22 The Successful Bidder shall be responsible for all required trenching, civil work, and any associated costs.
- 12.23 The Successful Bidder shall provide all programming data required to achieve the specified functionality for each effected system (this includes situations where existing technology is being replaced with new technology). Such programming shall include (but is not limited to) programming of all alarms, events, triggers, timers, objects transmitting and receiving signals, networking, bandwidth settings, frame rates, images per second, permissions, integration between systems, and interfaces as well as programming of signal receiving centre equipment to provide 100% full functionality.
- 12.24 It is required that disruptions be minimized keeping the existing intrusion detection systems or video surveillance systems operational during the process of upgrading to the new systems until all devices from the new system are functional and ready to be used by the end user. Consideration for the critical nature of all facilities operations and occupants is crucial to the success of the project.
- 12.25 Any new materials used by the Successful Bidder to commission the existing devices to the new system shall be covered by the warranty under this contract.
- 12.26 All existing devices that will be re-used by the Successful Bidder shall be commissioned to the new systems as defined by the COT.
- 12.27 All existing devices that will be replaced with new devices under the scope of work of any specific project shall be removed by the Successful Bidder. The removal of existing equipment or parts which will not be used with the new installations shall be completed by the Successful Bidder. Parts in working order are to be returned to address noted below. Other parts to be disposed by bidder.

**Scarborough Civic Centre,
Lower Level, Security Storage Room
150 Borough Drive
Toronto, Ontario, Canada
M1P 4N6**

Working parts under 5 years old to be return are as follows:

- Electric Strike
- DVRs, NVRs
- Servers
- Security Network Switches
- Cameras
- Camera Mounts
- Encoders

- UPS
 - Request to Exit Buttons
 - Intercoms
 - Wall mounted duress buttons
 - Sirens
 - Communication Boards/Panels
 - Long Range Motion Sensors
 - Maglocks
- 12.28 Where this section applies, the Successful Bidder must provide the City a minimum of 24-hours' notice of delivery of old functioning electronic security hardware, electro-mechanical security hardware, and mechanical hardware. All other equipment not required to be delivered to the City shall be disposed of at the Bidder's expense.
- 12.29 All costs and expenses associated with returning old equipment shall be the responsibility of the Successful Bidder.
- 12.30 The Successful Bidder shall reuse existing conduit runs whenever feasible and run new cabling in the existing conduit runs. Where existing conduit is used the new and existing cables must not experience any negative performance indications. Any deficiencies found after installation must be corrected by the successful bidder at no cost to the COT.
- 12.31 The Successful Bidder shall be responsible for patching up holes left by existing equipment and making good all repairs where new equipment is being installed in the same place.
- 12.32 All installed equipment shall be fully functional and shall be capable to be monitored at each individual site as well as the Corporate Security Control Centre located at 703 Don Mills Road.
- 12.33 Devices such as communication boards or input/output boards shall not be installed on door of panels. Additional panels shall be installed by the Successful Bidder to accommodate the installation of such devices.
- 12.34 Upon completion of the installation of the equipment at each location, the Successful Bidder shall provide to the Project Manager the serial numbers and model numbers of all newly installed equipment, these are to be included in the Summary of Security Devices Table referenced in section "As-Built Documentation 11.7".
- 12.35 The Successful Bidder shall install plywood backboards for mounting of all infrastructure equipment which require such backing to be able to be safely mounted to a wall such as electronic key cabinets, panels, and power supplies, etc.
- 12.36 Connect equipment to the closest approved available panel/switch/computer with available inputs and outputs.
- 12.37 Any new and existing cables for all devices which are exposed on the surface of a wall or ceiling or any other accessible surface shall be placed in conduit or wire moulding by the Successful Bidder as directed

by the COT. This conduit/moulding shall be sized to allow for additional 25% increase in cable and include a cable pull string for future use. Type of conduit/moulding to be confirmed on specific project site meetings with COT. Plenum rated cable must be used in any spaces requiring plenum rated cabling as per building and/or electrical code. All cabling, conduit, and installation methods utilized must meet COT IT Cabling Standards, manufacturer recommendations, and both the Electrical and Building Codes.

- 12.38 All infrastructure equipment including power supplies, transformers, communication devices, controllers, recording devices, etc. must be installed in secure cabinets. The Successful Bidder shall provide and install such cabinets and mount all of the equipment inside the cabinets. All costs for such cabinets shall be included in the quoted price.
- 12.39 Video Surveillance installation and camera field of view shall be in compliance with applicable local privacy laws, the City video surveillance privacy policy and shall be approved by the Corporate Security Lead.
- 12.40 All IP enabled devices such as IP Cameras, Encoders, iStar's, NVR's, card readers, controllers, etc. shall be tagged with an appropriate device name in coordination with the Corporate Security Lead.
- 12.41 Typical naming conventions are as follows however final naming convention shall be coordinated with and approved by the Corporate Security Lead prior to the commencement of any device setup or installation:
- Site Address-NVR/Controller Number/Name
 - NVR's shall be numbered sequentially as added
 - Device numbers shall match port number on attached switch or controller
 - Ex: 1008YNG-NVR9-CAM3
- 12.42 All IP Cameras and Encoded Cameras shall be programmed on the VSS to display a short form naming. This Naming shall be coordinated with and approved by the Corporate Security Lead prior to configuring the VSS.
- Typical Camera/device short FORM name on Milestone system would be:
1008YNG-F3-NW STAIR-3
- 12.43 The Security Contractor shall carry the cost of all required access hatches where required and shall patch and paint to match existing paint; all locations for access hatches shall be pre-approved by the Corporate Security Lead in writing before working on these access hatches.

13.0 VSS Design Criteria

- 13.1 The VMS architecture shall permit centralized administration and management for the IP VSS and its distributed components across the City's local and wide area corporate networks. This administration

shall be redundant providing seamless failover capabilities and continuous operation in the event of failure of one of the main IP VMS services.

- 13.2 The VMS shall allow for continuous system management and operation through resilient server clusters on the City provided domain, between 55 John Street and 703 Don Mills. This resiliency shall span the Management, SQL Database and Event servers providing continued operation at the primary and/or the secondary site depending on failure cause and location of components, infrastructure and/or related services.
- 13.3 The VMS shall allow for administering and managing the complete VSS system from any workstation having the Milestone XProtect® management client application installed and connected to the Corporate Security Lead's Corporate Network.
- 13.4 The VMS shall keep all (Audit, Event, and Rule and System logs) for duration of 60 days. Any storage or other specifications required from the Corporate Security Lead provided equipment shall be included and provided by the security contractor to the Corporate Security Lead as part of the server Specifications required.
- 13.5 The following will be supplied by the City of Toronto:
- Microsoft SQL Software and Licenses
 - Physical Servers required for Milestone VMS Management Services including Microsoft Windows Server 2008/2012 Licenses:
 - Management Server
 - Event Server
 - SQL Server
 - Mobile Server
 - Client (user) Workstations
 - VSS Core Network Switches (Cisco Switches)
 - VSS Access Layer Switches (Cisco Switches)
 - SAN Network Switches (Cisco Switches)
 - Ethernet Cat6A Patch Panels
 - Fiber Patch Panels in VSS Racks
 - Fiber connectivity between existing telecom rooms, entrance facilities and equipment rooms.
- 13.6 The Security Contractor shall specify the required Cisco switch models, and configuration required for the VSS, and the SAN to operate fully (including interface modules, IOS software, ports, Supervisor Engine, Backplane BW, POE Power/port, QOS Groups & Types, etc....). It is the responsibility of the Security Contractor to ensure specified network infrastructure is adequate for the complete system operation in normal and failover modes. The Security Contractor is responsible to coordinate and provide all detailed server specifications required for the system full operation to the Corporate Security Lead IT departments. Should the switch be determined to not be functionally appropriate by the COT, it shall be replaced by the successful bidder with an appropriate device at no additional cost to the COT.

- 13.6.0 Provide all VSS components and accessories required for achieving the full required functionality including but not limited to IP cameras, power supplies (Where Applicable), transmission media converters and extenders, modules, Video Encoders, mounts, enclosures, cables, plenum rated back boxes/enclosures/kits and IR Illuminators etc....
- 13.6.1 The only acceptable video compression (digital encoding) method shall be non-proprietary H.264 encoding (Baseline and/or Main Profile)
- 13.6.2 The VMS shall transmit and communicate over Corporate Security Lead IP network LAN/WAN, Fibre cables, Ethernet cables, Coaxial cables and Elevator installed coaxial cable infrastructure.
- 13.6.3 The Security Contractor shall warranty and ensure network bandwidth transmission performance, display, compression and network latency, PC client workstation, NVR's, SAN's and VMS server performance is designed and engineered to be sufficient, functional and in accordance with Milestone Systems VMS equipment and VSS hardware manufacturer.
- 13.6.4 The Security Contractor shall be sensitive to network bandwidth requirements and communicate all requirements to the Corporate Security Lead. It will be the sole responsibility of the Security Contractor to design and engineer all network transmission paths under the performance conditions of this specification and the requested deliverables.
- 13.6.5 All VSS Servers and workstations will have corporate antivirus agents installed by the Corporate Security Lead's IT Team prior to the installation. The additional travel time incurred by the successful bidder for deliveries to required sites for programming shall be at no charge to the COT.

14.0 Video Recording

All video must be stored for 37 days. The local NVR disks must be capable of recording for the full thirty seven (37) days, at full system capacity.

14.1 Network Video Recorders

Minimum requirements include:

- 14.1.0 RAID1 OS Volume array (2 x 240GB SSD)
- 14.1.1 RAID controller with minimum 512MB Battery backed cache
- 14.1.2 Enterprise Remote management capabilities, with virtual media and console access capabilities c/w out-of-band interface
- 14.1.3 RAID 1 Volume array for recording live video (15K RPM or better).

- 14.1.4 RAID 5 Volume array for archived video (7.2K RPM or better).
- 14.1.5 At least one global hot spare
- 14.1.6 All hard drives shall be Enterprise / Data centre grade
- 14.1.7 All DISK I/O's should run at no more than 80% of the maximum System capacity under normal operating conditions including Antivirus software, Encrypting Video and other required system services. 20% overhead shall remain free.
- 14.1.8 NVR's shall be equipped with Enterprise server network cards
- 14.1.9 Each NVR shall be equipped with two network ports for live viewing and two separate ports for recording video. All camera recording streams shall be on a separate VLAN.
- 14.1.10 Each NVR shall have a redundant and resilient connection to the SAN (where applicable) through a dedicated network
- 14.1.11 NVR Hardware shall be off-the shelf HP or DELL Servers
- 14.1.12 The NVR solution and design shall be certified and approved by Milestone Systems to meet the performance requirements of the VMS solution.
- 14.1.13 All Recorders to be configured and connected to COT centralized Milestone management system

14.2 Class A Recorder

Recording 16 or less local IP Video or Camera streams each streaming H.264 compressed video at a resolution of 1920x1080p, frame rate of 15fps, stream bandwidth of 2400Kbps/Stream, with 100% estimated scene motion, and continuously recording for 24hrs for a total of thirty seven [37] days retention period without any altering or compression to original recorded streams (i.e.: reducing P frames, or other compression techniques)

Allow for thirty-seven [37] days continuous recording on the local NVR RAID5 Storage Array with hot spare disk.

The following is an example of the required NVR. Equivalents, or others, approved by Milestone to be presented to City Of Toronto for an approval.

Primary/Redundant NVR Specifications	
Requirements	
Processor/Chipset	1 x Intel Xeon E5-2620 v3 2.4GHz or COT approved equivalent
Operating System	Microsoft Windows Server 2012 x64 Standard
Monitor	Refer to TR Typical for KVM requirements
System Memory	Minimum 32GB 1600MHZ DDR3 Memory
Hard Drives/OS	2 x 240GB Solid State SATA drives, 6Gbps 2.5in Hot-plug Drive, 3.5in (Raid 1)
Hard Drives/Live video	2 x 600GB 15K RPM SAS 2.5in Hot-plug Hard Drive, 3.5in (Raid 1)
Hard Drives/Archive	5 x 8TB 7.2K RPM SATA 6Gbps 512e 3.5in Hot-plug Hard Drive (Raid 5 + Hot spare)
RAID Controller	Enterprise Class Raid Controller with minimum 1GB Cache, supporting required disks and RAID levels with battery backup and write-back cache support.
Graphics	On board
Network	Broadcom 5720 QP 1Gb Network Daughter Card
I/O Ports	USB 2.0 or USB 3.0
Chassis Type	Rack mount, c/w pull out rails (tool-less mounting with square holes) Chassis with up to 12, 3".5" Hard drives + 2, 2.5" Flex Bay Hard Drives
Expansion Slots	Minimum 3x PCIe (2x16 Bandwidth, x8 Bandwidth)
Security	Chassis Intrusion Switch Setup/BIOS Password; lockable bezel
Remote Management	Enterprise remote virtual media and console access capabilities c/w out-of-band interface (Ex: iDRAC7 Enterprise or COT approved equivalent)
Power	Dual, Hot-plug, Redundant Power Supply (1+1), 750W
Support	4-Hour 7x24 On-Site Service with Emergency Dispatch, 3 Year

14.3 Class B Recorder

Recording 32 or less local IP Video or Camera streams each streaming H.264 compressed video at a resolution of 1920x1080p, frame rate of 15fps, stream bandwidth of 2400Kbps/Stream, with 100% estimated scene motion, and continuously recording for 24hrs for a total of thirty seven [37] days retention period without any altering or compression to original recorded streams (i.e.: reducing P frames, or other compression techniques)

Allow for thirty-seven [37] days continuous recording on the local NVR RAID5 Storage Array with hot spare disk.

The following is an example of the required NVR. Equivalents, or others, approved by Milestone to be presented to City Of Toronto for an approval.

Primary/Redundant NVR Specifications	
Requirements	
Processor/Chipset	1 x Intel Xeon E5-2620 v3 2.4GHz (or COT approved equivalent)
Operating System	Microsoft Windows Server 2012 x64 Standard
Monitor	Refer to TR Typical for KVM requirements
System Memory	Minimum 32GB 1600MHZ DDR3 Memory
Hard Drives/OS	2 x 240GB Solid State SATA drives, 6Gbps 2.5in Hot-plug Drive, 3.5in (Raid 1)
Hard Drives/Live video	2 x 900GB 15K RPM SAS 2.5in Hot-plug Hard Drive, 3.5in (Raid 1)
Hard Drives/Archive	8 x 8TB 7.2K RPM SATA 6Gbps 512a 3.5in Hot-plug Hard Drive (Raid 5 + Hot spare)
RAID Controller	Enterprise Class Raid Controller with minimum 1GB Cache, supporting required disks and RAID levels with battery backup and write-back cache support.
Graphics	On board
Network	Broadcom 5720 QP 1Gb Network Daughter Card
I/O Ports	USB 2.0 or USB 3.0
Chassis Type	Rack mount, c/w pull out rails (toolless mounting with square holes) Chassis with up to 12, 3".5" Hard drives + 2, 2.5" Flex Bay Hard Drives
Expansion Slots	Minimum 3x PCIe (2x16 Bandwidth, x8 Bandwidth)
Security	Chassis Intrusion Switch Setup/BIOS Password, lockable bezel
Remote Management	Enterprise remote virtual media and console access capabilities c/w out-of-band interface (Ex: iDRAC7 Enterprise or COT approved equivalent)
Power	Dual, Hot-plug, Redundant Power Supply (1+1), 750W
Support	4-Hour 7x24 On-Site Service with Emergency Dispatch, 3 Year

14.4 Class C Recorder

Recording 64-128 local IP Video or Camera streams each streaming H.264 compressed video at a resolution of 1920x1080p, frame rate of 15fps, stream bandwidth of 2400Kbps/Stream, with 100% estimated scene motion, and continuously recording for 24hrs for a total of thirty seven [37] days retention period without any altering or compression to original recorded streams (i.e.: reducing P frames, or other compression techniques)

Allow for thirty-seven [37] days continuous recording on the local NVR RAID5 Storage Array with hot spare disk.

The following is an example of the required NVR. Equivalents, or others, approved by Milestone to be presented to City Of Toronto for an approval.

Primary/Redundant NVR Specifications	
Requirements	
Processor/Chipset	2 x Intel Xeon E5-2660 v4 2.0GHz (or COT approved equivalent)
Operating System	Microsoft Windows Server 2012 x64 Standard
Monitor	Refer to TR Typical for KVM requirements
System Memory	Minimum 64GB 1600MHZ DDR3 Memory
Hard Drives/OS	2 x 250GB Solid State SATA drives, 6Gbps 2.5in Hot-plug Drive, 3.5in (Raid 1)
Hard Drives/Live video	2 x 900GB 15K RPM SAS 2.5in Hot-plug Hard Drive, 3.5in (Raid 1)
Hard Drives/Archive	10 x 10TB 7.2K RPM SATA 6Gbps 512e 3.5in Hot-plug Hard Drive (Raid 5 + Hot spare)
RAID Controller	Enterprise Class Raid Controller with minimum 1GB Cache, supporting required disks and RAID levels with battery backup and write-back cache support
Graphics	On board
Network	2 x Broadcom 5720 QP 1Gb Network Daughter Card
I/O Ports	USB 2.0 or USB 3.0
Chassis Type	Rack mount, c/w pull out rails (tool-less mounting with square holes) Chassis with up to 12, 3'.5" Hard drives + 2, 2.5" Flex Bay Hard Drives
Expansion Slots	Minimum 3x PCIe (2x16 Bandwidth, x8 Bandwidth)
Security	Chassis Intrusion Switch Setup/BIOS Password, lockable bezel
Remote Management	Enterprise remote virtual media and console access capabilities c/w out-of-band interface (Ex: iDRAC7 Enterprise or COT approved equivalent)
Power	Dual, Hot-plug, Redundant Power Supply (1+1), 750W
Support	4-Hour 7x24 On-Site Service with Emergency Dispatch, 3 Year

14.5 Using Ionodes as a mini-Dell Server

14.5.1. Steps for CoT Client IT

- Configure the unit to be in the same domain as the Milestone Management servers, recording servers as per their policy
- Configure one of the NIC cards of the unit to have IP address configuration that can reach the Milestone Management server
- Configure the other NIC card of the unit to be in the local IP subnet of the site IP cameras/encoders
- Provide the IP address/domain name of the milestone management server to the Met-Scan install crew
- Provide the required network connectivity from a site to reach the management server:
 - a. Ports to be opened similar to what is being done in induction of new DELL servers to the management server
 - b. Would need IT assistance when the unit is having difficulty to reach the network with this regard instances such as:
 - i. in the network layer level using command prompt

- ii. difficulties in opening the management server download web page
 - iii. Difficulties in reaching the management server in the handshake process that happens when installing the Milestone recording server application.
- Add the milestone device licenses to the management server.

14.5.2. Steps for Vendor:

- Configure the storage to store video.
 - a. A recording folder will be created for the one-day live storage
 - b. 2nd folder will be created for the archive in the drive allotted to data.
- Download the recording server application into the unit from the Milestone management server download page using the IP address/domain name of the management server provided by IT
- Install the recording server app in the unit that requires assistance from IT if there is a difficulty in the handshake process with the management server due to network/ports issues
- Add the cameras to the recording server and adjust settings as per COT requirements
- Use the same install procedure that is used for DELL server classes, and we install:
 - I. Recording server application.
 - II. Device pack
 - III. Management Client and Smart Client apps
- Two drives in the unit are configured as a spanned array to be one volume as per directions from IONODE, as shown in the image below. The one volume is formatted with 64K block size/Indexing off, keeping with Milestone requirements that contains two folders, one for Live and one for Recordings.
 - I. Maximum storage capacity available with IONODES is 20 TB (nominal)
 - II. Considering a 10% overhead for storage housekeeping, which brings down the usable capacity to 18 TB.
 - III. This usable capacity (18 TB) will allow about 16 streams at a 2.4 kbps bit rate (12 streams plus 25% capacity for future growth).

15.0 VSS Storage Area Network (SAN)

15.1 The SAN shall have the following minimum requirements:

- Equipped with redundant and hot-swappable power supplies and cooling Fans
- Support hot-swappable drives, each configured RAID 5 volume should be configured to have a hot spare disk available
- Support both iSCSI (1GB, 10GB), FCoE (10GB), FC (4-16GB) with Hot Swappable controllers
- Provide a minimum effective (Usable) total storage capacity of RAID5 configured arrays to allow for the required video storage retention of 30 days from each of the NVR's connected to it
- Expandable to allow for additional 30% effective storage capacity and the connectivity of additional two [2] NVRs
- Support redundant and load balancing SAN connectivity to each NVR Server.
- Support multiple RAID levels on connected storage within an array

- Enough processing power and backplane bandwidth to support the total IOPS required for recording and retrieval of the video to and from the storage array.
- Enough memory bandwidth to support the buffering and queuing of system I/O's and transferred data.
- Equipped with battery backed cache for all array controllers (minimum 512MB)
- Intuitive enterprise level management and monitoring interface that can scale across the multiple SAN's
- Preference for remote monitoring and support features

15.2 The SAN shall be connected on its own dedicated local network; the security contractor shall provide the Cisco Network switches specifications and Media interface types required and coordinate these requirements with the Corporate Security Lead Networking Team. SAN network traffic shall not interfere with the any other network traffic.

15.3 All Patch Cables, labeling and connectivity between the SAN, Servers and SAN Network shall be the responsibility of the Security Contractor.

15.4 The management interface of the SAN shall be connected to the Corporate Security Lead's corporate network to allow for remote management and control.

15.5 The SAN solution and design shall be certified and approved by Milestone Systems to meet the performance requirements of the VMS solution.

15.6 Dell products are preferred, however alternatives approved by Milestone and which meet the above specifications will be considered.

DAS devices can be used instead of SAN where approved by the COT. The specified DAS must be approved by Milestone, achieve the desired recording duration, and allow for 25% video surveillance system growth. Dell and HP products are preferred, alternatives would have to be approved by the COT.

The below are the minimum DAS requirements. Equivalents, or others, approved by Milestone will be considered.

Minimum Specifications
Hardware
Minimum 8GB RAM
Dual Controller Array configuration
RAID Array Controller w/I GB Battery Backed Cache

DUAL Hot Swappable 10/100/1000 Ethernet Controllers with 4 ports each
Disk Configuration
SATA 7.2k RPM or better disks (Size or Disks Varies with required Storage, min 4TB disks rated for Enterprise DAS Storage and Video streaming applications)
Storage Volume to be configured as a RAID 10 Array

16.0 Cameras

- 16.0.1 Install dome cameras in flush surface or drop ceiling with concealed cabling
- 16.0.2 Configure cameras internal access with a new Username/Password credentials and **remove default logins**
- 16.0.3 Configure cameras with secure access protocols, VLANs, QOS and other network settings in coordination with the Corporate Security Lead. Cameras shall be totally secured to authorized access before being connected to the Corporate Security Lead's Network
- 16.0.4 All Cameras include elevator cab cameras shall be named in coordination with the Corporate Security Lead naming scheme and configured to sync with the Corporate Security Lead's local NTP server/VMS system
- 16.0.5 Configure each camera stream settings including but not limited to frame rate, bitrate, compression, stream name, day night setting, and other related configuration in coordination with the Corporate Security Lead. All configurations shall be approved by the Corporate Security Lead before setting and configuring the devices
- 16.0.6 Configure and calibrate cameras for the lighting conditions at each camera location including setting shutter speeds, AWB, Exposure levels, Day/Night mode, WDR, AGC, and other related settings to produce optimal video pictures under all operating conditions
- 16.0.7 Ensure Cameras are operating the latest firmware version or as recommended by the manufacturer at time of installation.
- 16.0.8 Backup all camera settings/configurations in addition to the VMS configurations to a CD/DVD and submit to Corporate Security Lead.
- 16.0.9 Ensure outdoor cameras and their heater are properly powered to operate normally in all environmental conditions referenced in this section

16.0.10 All cameras with analytics capabilities shall be setup and calibrated for the supported alarms. Typical alarms to be configured by default for all cameras include:

- Motion in full or designated field of view zones
- Video Masking
- Video Loss/Gain
- Network Loss
- Device I/O's

16.0.11 Configure logging and network troubleshooting capabilities on each IP cameras in coordination with the Corporate Security Lead.

16.0.12 Configure Network Security features and settings on each camera in coordination with the Corporate Security Lead.

16.0.13 For PTZ cameras configure Masks, home position, pre-sets, control sensitivity, image mode and other related settings in coordination with the Corporate Security Lead.

16.0.14 All camera installations and field of view setup shall meet the VSS primary functions identified by the Corporate Security Lead. The following minimum resolution requirements are required for each of the VSS functions below:

- General Observation: >20ppf on farthestmost desired target
- Forensic Review (General Identification) : >40ppf on farthestmost desired target
- Recognition including Facial, vehicle license plate, color, pattern, and cross-line recognition: > 80ppf on farthestmost desired target
- All camera views, resolution and image color and quality, shall pass the approval of the Corporate Security Lead.

16.1 IR Illuminators

All IR illuminators specified for specific camera installation projects are to be:

- Mounted and calibrated not to over expose the image quality during night time operation.
- All IR accessories shall be POE Powered unless otherwise approved by the Corporate Security Lead.
- All IR shall be IP66, Vandal resistant and mounted securely or be built-in to the camera. .4 IR 850nm wavelength, equipped with a Photocell and configured to activate on environmental lighting conditions.

17.0 Video Encoders

17.1 The following are the minimum performance specifications for Video Encoders to be specified by the successful bidder:

- 17.1.0 Rack mounted
- 17.1.1 Flexible and Expandable allowing for hot swappable blades (applies to encoders for 1 channels or more)
- 17.1.2 Equipped with redundant hot swappable power supply and fans (applies to encoders where more than 8 channels are required)
- 17.1.3 Each encoder channel shall support H.264 video compression, a minimum of two simultaneous streams at 720 (horizontal) × 486 (vertical) NTSC analogue video resolution and 30fps.
- 17.1.4 Each encoder channel shall have a minimum of one [1] configurable input/output .6 Security Contractor shall ensure the encoders support the PTZ protocols and control connectivity (RS-485, RS-422) for connected PTZ analogue cameras
- 17.1.5 Each encoder shall support the following analytics for each video channel and shall trigger an alarm on Milestone Systems XProtect Corporate® VMS:
 - i. Camera repositioning
 - ii. Camera lens is masked, sprayed, covered or blocked
 - iii. Motion detection in defined zones of the camera view, minimum five [5] zones
- 17.1.6 Each Encoder shall support the following alarms and shall be annunciated on the Milestone monitoring interface:
 - i. .1 Video Signal loss /gained per channel
 - ii. .2 Network loss/gained
- 17.1.7 Encoder shall be ONVIF compliant and supports (Profile S)
- 17.1.8 Encoder shall support the following protocols: IPv4/v6, HTTPS, SSL/TLS, QoS Layer 3, FTP, CIFS/SMB, SNMPv1/v2c/v3 (MIB-II), DNS, NTP, RTSP, RTP, TCP, UDP, IGMP, RTCP, ICMP,DHCP.
- 17.1.9 Shall support remote firmware upgrade.
- 17.2 All Encoders shall be rack mounted in a proper cabinet.
- 17.3 Configure each encoder interface and chassis (where applicable) with secure access protocols, VLANs, QOS and other network settings in coordination with the Corporate Security Lead. Cameras shall be totally secured to authorized access before being connectedto the Corporate Security Lead’s Network

- 17.4 Each encoder channel shall be named in coordination with the Corporate Security Lead naming scheme and configured to sync with the Corporate Security Lead's local VSS NTP server/VMS system
- 17.5 Configure each channel stream settings including but not limited to frame rate, bitrate, compression, stream name, day night setting, and other related configuration in coordination with the Corporate Security Lead. All configurations shall be approved by the Corporate Security Lead before setting and configuring the devices
- 17.6 Ensure Encoders are operating the latest firmware version
- 17.7 Backup all Encoders settings/configurations in addition to the VMS configurations to a CD/DVD and submit to Corporate Security Lead.
- 17.8 Ensure Encoder chassis is powered through a UPS and backup power to operate normally in all environmental conditions referenced in this section
- 17.9 All encoder channels with analytics capabilities shall be setup and calibrated for the supported alarms. Typical alarms to be configured by default for all cameras include:
 - i. Motion in full or designated field of view zones
 - ii. Video Masking
 - iii. Video Loss/Gain
 - iv. Network Loss
 - v. Device I/O's
- 17.10 Configure logging and network troubleshooting capabilities on each channel and encoder chassis in coordination with the Corporate Security Lead.
- 17.11 Connect and configure PTZ Data control protocols and settings on channels that are connected to analogue PTZ.

18.0 Ethernet Media Extenders

The following are the minimum performance specifications for Ethernet Media Extenders to be specified by the successful bidder in the event that the required product is not listed in the Price Form:

1. Any camera that exceeds the standard 100BASE-TX connectivity distance limitation requires: 100Mbps Ethernet extenders to extend transmission with POE pass-through over standard 75Ω coaxial cables
2. Extended Pass-through POE: meets the IEEE 802.3af standard for Power over Ethernet
3. Supports Jumbo Frame Transmission
4. Extends up to a minimum of a minimum of 548m at 100BaseT with POE pass-through .5 Suitable for high bandwidth requirements of Mega-pixel cameras
5. Aluminum Enclosure

6. Meets NEMA TS-1/TS-2 environmental requirements

18.1 POWER AND ETHERNET OVER COAX

The following are the minimum performance specifications for Power and Ethernet over Coax devices that are to be specified by the successful bidder:

18.1.0 Proposed IP and PoE/PoE+ over Coax solution shall, as a minimum, meet the following requirements:

- a. Provide enough PoE or PoE+ (IEEE 802.3af/802.3at) to Power the IP devices in all conditions and up to 50W (ex: When built-in heater is activated, PTZ, blower where applicable)
- b. Provide adequate output power to power the devices and provide Ethernet transmission over the various types, lengths and quality of wiring existing at the locations in scope
- c. Has minimal end-to-end Latency of $\leq 3\text{ms}$ that shall not affect the Video/Ethernet transmission over Coax
- d. Transceiver unit close to the edge device shall operate normally in outdoor environmental conditions as mentioned under paragraph (2.3.2.1.2 Outdoor) and shall not require an extra power source to operate.
- e. Provide transient overvoltage and electrostatic discharge protection and immunity to a minimum of: $5\text{x}20\mu\text{S}$ 3,000A 6,000V; ESD protection for 200pF 20KV.
- f. Provide an encrypted Coax link with a minimum of 128Bit AES encryption.
- g. Head-end transceivers shall be rack mounted in standard 19" rack cabinets, for single channel transceivers a rack mounting kit shall be used to securely and neatly mount a single transceiver to the rack (placing unit on trays or loosely in the cabinet is not acceptable).

18.2 VSS POWER COMPONENT

The following are the minimum performance specifications of VSS Power Components that are to be specified by the successful bidder.

- #### 18.2.0
- All VSS system components including but not limited to (POE Switches, Camera power Supplies, NVR Servers, VMS Servers, Encoders, Media converters, KVM Switches, Environmental and Cabinet Sensors, SAN etc....) shall be powered from a UPS backed by emergency power (where available) allowing for continuous, un-interrupted, operation of the complete VSS system for duration specified by COT during project quote phase. COT will require proof of MSRP from UPS manufacturer with MSRP discount applied as provided in the Price Form. The UPS system shall protect connected equipment from brownouts, overvoltage and other power irregularities.

- 18.2.1 All UPS equipment shall be securely rack mounted in cabinets. UPS equipment shall not be placed on shelves, installed on the ground or placed inside cabinets without proper rack rails or rack mounting kits unless approved by the Corporate Security Lead.
- 18.2.2 The complete IP VSS system and its distributed components shall be connected to a UPS for continued operation (provisioned at maximum power usage) where a backup circuit is available. The required power backup operation window shall include the provisioning for future expansion.
- 18.2.3 In addition to the above requirement the following shall apply for UPS selection and sizing:
- Securely rack mounted in a secure lockable cabinet
 - Sized to allow for a minimum of 40% extra power for future expansion
 - cUL listed and meets the following standards: UL 1449, UL 1778, CAN/CSA-C22.2 NO. 60950-1-07 (R2012)
 - Provides surge protection and filtering
 - Supports USB management, c/w windows software and management application to allow for server controlled shutdown upon reaching a set low battery threshold or internal Web based management interface
 - Alarms when on battery and c/w status LED indicators for normal operating mode, alerts and battery backup mode
 - Maintenance-free, sealed, user-replaceable and leak proof Lead-Acid Battery w/c automatic self-testing circuitry detecting and ensuring proactive alerts for battery replacement and/or faults
 - Resettable circuit breaker and automated recovery, ensures protection of connected loads from surges, spikes, lightning and other power disturbances
 - Medium & Large TR's to be equipped with expandable and upgradable rack mounted UPS units including sliding rack rails allowing for ease of maintenance, upgrades and serviceability
- 18.2.4 All new VSS IP Cameras shall be powered by PoE or PoE+ from respective PoE capable switches or Ethernet with PoE/PoE+ pass through media extenders. No exceptions are accepted unless for special purpose cameras requiring external power where applicable. This exception shall be approved in writing by the Corporate Security Lead.
- 18.2.5 IP and PoE/PoE+ over Coax solution shall be used to power IP cameras in analogue to IP cameras retrofit scenario. All new IP cameras shall be powered by PoE/PoE+ and shall not be connected to existing power supplies that are not connected to a UPS System.
- 18.2.6 PoE power provisioning shall be communicated and coordinated with the Corporate Security Lead and Corporate Security Lead's Networking Team and specified as part of the Cisco Network equipment. No assumptions of PoE/PoE+ power availability shall be made on any Corporate Security Lead provided network access switches unless previously coordinated and requested in writing from the Corporate Security Lead.

19.0 Equipment Cabinets/Racks

The Security Contractor shall be sensitive of the equipment room's space availability at the various locations in scope for rack installations. High density and low profile equipment should be considered in the proposed equipment design to reduce space requirements. The security contractor shall advise the Owner of any space required for additional rack quantities beyond what is provided and specified in the project scope. Corporate Security requires a dedicated secured rack for all security installations.

The following are the minimum performance specifications of various cabinets and enclosures that are to be specified by the successful bidder:

19.1 NEMA 12 – Rack Cabinets W/ Self-Contained Cooling Unit

- Pre-assembled before delivery
- Fully gasketed openings including gland plate in base
- Closed loop air-conditioning system, adequately sized to match equipment heat dissipation and cooling requirements (shall not require any piping, wiring or drainage) and shall also allow for 25% increase in heat generation of specified equipment. .4 Internal evaporator to eliminate condensation
- M6 Rail Type
- Plexi or Solid Doors
- Key Lockable secure doors and side panels
- Include casters and levelers
- Compatible vertical mounted PDU's
- Include cable management (vertical and horizontal lacing bars, front to back cable managers, bottom brush grommet kit, filler panels etc....) required for a neat cable and equipment installation
- Include grounding kit and ground appropriately
- Cabinet Size and Cooling Requirements shall be approved by Corporate Security Lead

19.2 NEMA 12 - Wall Mount Cabinets

- Pre-assembled
- Double hinged allowing access to the front and back side of cabinet

- NEMA 12 Fan Assembly
- Independent Key lockable from front and back side
- Lifetime Warranty
- M6 Rail type
- Include cable management (vertical and horizontal lacing bars, front to back cable managers, bottom brush grommet kit, filler panels etc....) required for a neat cable and equipment installation
- Cable management trays, and arms
- Include grounding kit and ground appropriately

19.3 Standard Rack Cabinets

- 42 U, Pre-assembled before delivery
- Vented Side Panels, with key locks
- Casters and levelers
- M6 Rails
- Split doors back and front side, with key locks
- 6 x 4" fans top panel
- Include grounding kit and ground appropriately
- Include Vertical PDUs
- Include cable management (vertical and horizontal lacing bars, front to back cable managers, bottom brush grommet kit, filler panels etc....) required for a neat cable and equipment installation
- Cable management trays, and arms

20.0 Real-Time Environmental Monitoring Component

- Provide real-time, Ethernet (IP) based environmental monitoring solution at each in of the existing and new VSS designated racks.

- The monitoring unit shall be rack mounted
- Shall have a dual temperature/humidity sensor, intelligent water temperature sensor and door contact sensors for each cabinet door
- The monitoring component shall be connected to the City corporate network
- Capable to notify the Owner of any changes or detections by the sensors in a variety of ways including e-mail and SNMP
- Supports SNMP v1, v2, v3
- Manageable through an intuitive web interface

20.1 RACK KVM TRAY

The following are the minimum performance specifications of Rack KVM Trays that are to be specified by the successful bidder.

- Integral KVM Switch with keyboard, LCD monitor, and touch pad in 1U FORM .2 Allows remote network user access through KVMoIP over WAN & LAN
- Full Sized 105-Key keyboard
- Ergonomic hand rest
- Includes Universal Rear Rail Kit
- CE, RoHS approved
- Flip Open Monitor Minimum 19" TFT LCD monitor, 1280 x 1024 @ 60 Hz .8 Dual Rail Flip Open Monitor when Keyboard and Mouse are closed
- Control via on-screen display (OSD) menu, push buttons Selection Buttons on monitor bezel, hotkeys, or mouse.
- Connects to servers through CATx patch cables and required server access modules
- 16-Port CATx KVM
- Provide BIOS Level Access

21.0 Labelling

- 21.1 All cables shall be tagged, with a unique number, in common at both ends using a permanent method. Labelling shall agree with record drawings and point allocation tables and to indicate source and destination information.
- 21.2 All terminals shall be permanently tagged and shall agree with record drawings.
- 21.3 All system power supplies shall be labelled with their feed source and breaker number.
- 21.4 All connectors shall be marked with common designations for mating connectors. The connector designations shall be indicated on the record drawings.
- 21.5 All visible panel and control labels shall be silk-screened, engraved and filled, or engraved plastic laminate. Labels shall be permanently attached.
- 21.6 Labelled Doors and Frames in no instance shall any labelled fire door or frame be cut, penetrated, drilled or modified in any way.
- 21.8 Any labelled door or frame which shall require modification to meet the system specifications shall immediately be brought to the attention and written approval of the Project Manager.

22.0 Conformity of Work with Plans and Specifications

- 22.1 The Successful Bidder shall perform all Work and furnish all materials and complete the whole of the Work in conformance with the requirements.
- 22.2 Any Work or material not herein specified but which may be fairly implied as indicated in the Contract or obviously necessary for the proper delivery of a fully functional system, shall be done or furnished by the Successful Bidder as if such Work or material had been specified.
- 22.3 The Successful Bidder shall at all times have on the Work site, competent Personnel capable of reading and thoroughly understanding the plans and specifications, and thoroughly experienced in the type of Work being performed. Such Personnel shall include the supervision and direction of all Subcontractors, if any are used. The designated Personnel shall have available at all times the lists/floor plans required.
- 22.4 Upon request, the Successful Bidder shall provide the City of Toronto Corporate Security a list of all Personnel's duties, responsibilities, and obligations for the Work required.

23.0 Supply and Install Project Procedures

- 23.0.0 The City of Toronto Corporate Security and the Successful Bidder shall follow the procedures set-out in General Contract Terms and Conditions for all supply and install Work. The standard Security Project Work Package which will be provided to the Successful Bidder has been created to ensure consistent implementation/execution of the individual projects regardless of the projects size and scope.
- 23.0.1 Prior to the execution of any supply and install projects the Successful Bidder shall familiarize and comply with the project procedures set-out in General Contract Terms and Conditions, Supply and Install Procedures Package.

23.1 General Specifications

- 23.1.0 The Deliverables being supplied in this RFQ must be new and certified by the Vendor, and free of encumbrance. Refurbished, rebuilt, or used Products will not be acceptable.
- 23.1.1 All specifications are minimum requirements that must be met or exceeded. Bids containing one or more items that do not meet or exceed the minimum general specifications will be declared Non-Compliant.

24.0 IT Coordination

- 24.1 Coordinate with the Corporate Security Lead team for all equipment programming. Upon approval, connect, test all equipment and ensure there are fully and properly operating
- 24.2 All security equipment configurations shall be performed by the Corporate Security Lead IT Team in coordination, and support from the Security Contractor
- 24.3 All IP enabled devices with Username/Password parameters shall be configured with a designated temporary credentials and provided to the Corporate Security Lead. Default credentials shall be immediately removed upon initial power up and configuration of the device.
- 24.4 All typical configurations shall be coordinated and approved by the Corporate Security Lead IT Team before configuring the devices. The additional travel time incurred by the successful bidder for deliveries to required sites for programming shall be at no charge to the COT.

25.0 Licensing

- 25.1 The City prefers any net new licenses required to be a onetime purchase. Support and maintenance agreements should be independent of the software license.
- 25.2 The Vendor should be able to provide to the City at no additional cost at least one (1) copy of the Documentation for each copy of a licensed software.
- 25.3 The Vendor should be able to grant to the City a perpetual, non-exclusive, irrevocable, transferable, fully paid-up, royalty-free right and license to install, use, and copy (on storage units or media for backup or other contingency purposes), all or any portion of each licensed software, together with all associated Documentation, in accordance with the Terms of the resulting Contract and:
- i. the Vendor should provide to the City at least one (1) copy of each licensed software in installable FORM unless it has specified a greater number of copies;
 - ii. if the City is licensed to use any licensed software on any computer or computer complex, the City may transfer the licensed software to any different computer or computer complex without any fee or other charges being due to the Licensor;
 - iii. if the City is licensed to use any licensed software in conjunction with any operating system, the City may use the licensed software in conjunction with any other operating system without any fee or other charge being due to the Vendor if the licensed software is certified to operate on that other operating system when that use commences, regardless of whether the operating system was in existence or not in existence at the time the licensed software was originally licensed by the City;
- 25.4 If a CPU based license is provided, the CPU based license should be a perpetual license to use the licensed software on one physical CPU and such perpetual CPU license should not be conditional on any Terms and conditions not set out expressly in the Contract. The City may transfer the licensed software from one physical CPU to another physical CPU at any time or times without notice to the Vendor and without any fee or other charges being due to the Vendor. A CPU license for a physical CPU is not limited in any way by the use of multithreading, hyper-threading, or any quantity of logical CPU.
- 25.5 If concurrent user licenses are provided, then the concurrent user license should be a perpetual license to permit the use of the licensed software on a concurrent basis (limited to the number of simultaneous users of the licensed software) and such concurrent user license should not be conditional upon any Terms and conditions not set out expressly in the Contract. The Vendor should provide in the licensed software a utility to manage the list of users who are sharing the concurrent user license(s) and provide a mechanism within the licensed software to ensure that the contracted number of concurrent user license(s) is made available for users. The City may add to the number of users who can share the concurrent user license(s) at any time without notice to the Vendor and without any fee or other charges being due to the Vendor.

- 25.6 If named user licenses are provided, then the named user license should be a perpetual license to permit one (1) individual to use the licensed software and such named user license should not be conditional upon any Terms and conditions not set out expressly in the Contract. The City may transfer the named user license from one (1) individual to another individual at any time or times without notice to the Vendor and without any fee or other charges being due to the Vendor;
- 25.7 The Vendor should have the exclusive title to the licensed software and Documentation or otherwise have the right to grant to the City each license and every right under to each licensed software and the Documentation as contemplated by the Contract without violating any third party Intellectual Property Rights;
- 25.8 Each licensed software and the Documentation should be free from all encumbrances, should not, and will not contain any Disabling Code;
- 25.9 The Documentation should be well written, readily understood, and contain clear and concise instructions for users and system administrators of the licensed software and should include meaningful instructions to enable users and systems administrators to take full advantage of all of the capabilities of the licensed software including installation and system administration documentation to enable a system administrator to allow proper control, configuration and management of the licensed software;
- 25.10 For the duration of the Warranty Period, the licensed software will perform in accordance with the specifications and descriptions contained in the Contract, in the Vendor's published Documentation and specifications, and in the Documentation for the version of the software in use by the City;
- 25.11 The licensed software should be compatible with future releases of the operating system on which it was originally installed within one hundred and twenty (120) calendar days of general availability of the operating system and shall be subsequently maintained to remain so compatible;
- 25.12 The Vendor shall provide to the City, without additional charge, copies of the licensed software and Documentation revised to reflect any enhancements made by the Vendor and such enhancements will be deemed to include all Versions, Releases and other modifications to the licensed software which correct errors, increase the speed, efficiency, capacity or ease of operation of the licensed software, or add additional capabilities or functions to or otherwise improve the capabilities and functions of the licensed software; and
- 25.13 The Warranty Period of licensed software shall commence on the Initial Install Date of such licensed software.
- 25.14 Each software license granted pursuant to the Agreement should survive any expiry or termination of the Agreement.

26.0 Software Updates

The Successful Bidder shall provide all software updates and revisions to the City during the length of this contract term warranty period without cost to the City. The Successful Bidder must register and maintain all applicable Formal technical support agreements with manufacturers including but not limited to American Dynamics and Dedicated Micros, Milestones, BriefCam, Software House, CCURE9000, Key Tracer. Registration of the technical support agreements.

The Successful Bidder is responsible to maintain 100% functionality of the CCTV and AV Systems prior to and after scheduled updates are performed.

Where there is integration between City systems, the Successful Bidder must maintain integration compatibility and advise the City if software updates may impact the current integration performance and functionality.

27.0 Upgrades and Updates

Throughout the Contract Term and its Warranty period, the Successful Bidder shall provide notice to the Project Manager within 24-hours of all manufacturers' or software developer's release of a version, firmware, and/or patch upgrade and/or update for all security systems owned or operated by the City that pertains to this Contract.

The Successful Bidder shall include; without any additional costs to the City, all manufacturer and/or City of Toronto recommended application and operating system upgrades and updates including licenses, versions, firmware, hot fixes and patches to ensure continuous performance and continuity of City CCTV and AV Systems.

The Successful Bidder shall provide the City with all software upgrades and updates, in original packaging (where available), with original manuals/documentation, and original copies (compact discs, floppies, etc.).

28.0 Future System Expansion

The City reserves the right to have other qualified firms expand and/or add to the systems at any time.

The City reserves the right to make changes, alterations, additions, or deletions to any of the City's equipment.

29.0 Delivery and Installation

The Vendor must deliver the specified Deliverables as per their Quotation without substitution or deviation. All items shall be delivered F.O.B. Destination.

The Successful Bidder must deliver the specified Products and/or Services as per their Quotation without substitution or deviation.

The Successful Bidder shall provide staff who are qualified to undertake the installation Services required under the Terms of this RFQ. The staff must be certified to install and set-up the Products produced by the manufactures that are listed in the 33.0 Manufactures List.

The Successful Bidder shall restore all property temporarily removed, damaged, or destroyed during the supply, delivery, and installation, of Products to the satisfaction of the City and at no cost to the City. The Successful Bidder, before final payment, shall remove all surplus materials and any debris of every nature resulting from its operation and put the site(s) in a neat, orderly condition; thoroughly clean. If the Successful Bidder fails to clean up at the completion of the supply, delivery, and installation of the Products, then the City may do so and charge the Successful Bidder for the costs thereof, or deduct said costs from any monies still owing to the Successful Bidder.

The Successful Bidder shall furnish all labour, materials, Services, supplies, tools, equipment, apparatus, transportation, facilities and incidentals required and perform all operations necessary to accomplish the complete installation of the Product(s).

29.1 Return of Products

29.1.0 Should the Product fail to work upon arrival, or within thirty (30) days of arrival, the Product will be returned for a complete exchange of new working Product (same make and model), at no cost to the City. The Product must be exchanged within five (5) business days of notification. The Warranty Period of the replaced Product will be deemed to date from the day of replacement.

29.1.1 If the Product(s) do not function as warranted and the problem cannot be resolved to the satisfaction of the City, then the Product(s) may, at the sole discretion of the City, be returned for a full refund.

29.1.2 In the event an item has been discontinued by the manufacturer/supplier, the supplier must provide documentation to confirm the product is no longer available and provide a viable substitute that meets or exceed the current specifications at the same price.

The Vendor will be responsible for all costs associated with the return and replacement of any products which have been discontinued. This will include all freight, packaging and handling costs.

The City will not accept any changes related to the discontinued product. The City will not be responsible for any restocking charges associated with returns.

29.1.3 Bidders must not substitute contract approved product(s), commodity(s) or service(s) without prior written approval from City of Toronto Purchasing and Materials Management staff, on either City of Toronto letter head or City of Toronto originating email. Any approved substitution must meet or exceed the approved good, approved commodity or approved service to be substituted, at no additional cost to the City of Toronto.

30.0 Warranty

- 30.1 The Successful Bidder shall include a two (2) year Warranty for all parts and labour as per the Warranty conditions of this RFQ.
- 30.2 Warranty shall include all Preventive Maintenance for two (2) full year periods. This entails two site visits per warranty year.
- 30.3 If, within two (2) years after the date of final acceptance of the Work as determined by the Corporate Security Lead, or designated portion thereof, or within two (2) years after acceptance by the Corporate Security Lead of designated equipment, or within such longer period of time as may be prescribed by law, or by the Terms of any applicable special Warranty required by the contract, or applicable codes, any of the Work found to be defective or not in accordance with the contract, the Successful Bidder shall correct it after receipt of a written notice from the City to do so unless the City has previously given the Successful Bidder a written acceptance of such condition. This obligation shall survive termination of the contract. The City shall give such notice promptly after discovery of the condition.
- 30.4 All installed equipment, shall be subjected to its own Preventative Maintenance schedule; the schedule is to be submitted after final acceptance of equipment installation with the submitted as-builts. The Preventative Maintenance must be performed in accordance to NFPA 731 throughout the Warranty period, or a minimum of two times a warranty period whichever is greater, at no further cost to the City.
- 30.5 Nothing contained in the contract shall be construed to establish a period of limitation with respect to any other obligation that the Successful Bidder might have under the contract.
- 30.6 The establishment of the time period of two (2) years after the date of final acceptance, or such longer period of time as may be prescribed by law, or by the Terms of any Warranty required by the contract relates only to the specific obligation of the Successful Bidder to correct the Work, and has no relationship to the time within which its obligation to comply with the contract documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Successful Bidder's liability with respect to his obligations other than specifically to correct the Work.
- 30.7 If this contract in its specifications requires that specific deliverables must perform as a system, this representation and Warranty shall apply to the deliverables, individually, in combination with each other, and as a system. Where the Successful Bidder will be providing any component of a deliverable from or through a Subcontractor, the Successful Bidder shall cause its Subcontractor to comply with this representation and Warranty with respect to the component to be provided by such Subcontractor.
- 30.8 Where the deliverable being provided by the Successful Bidder has an interface with any other product and such interface is necessary for the functionality, operation or performance of its deliverable, the Successful Bidder shall ensure that such product complies with this representation and Warranty and such interface does not in any way impair the ability of its deliverable to comply with this representation and Warranty.

- 30.9 At the Corporate Security Lead's request made in writing at any time before or within 90 calendar days (or such other time period as designated by the City in writing) of its acceptance of the deliverable, the Successful Bidder will, at no charge to the City, demonstrate the compliance techniques and test procedures to be followed by the Successful Bidder or the City or its authorized agent to confirm that the deliverable complies with this representation and Warranty.
- 30.10 Where the Successful Bidder advises the City that its deliverable is not able to comply with this representation and Warranty at this time but will be able to do so by a specified date, the City may at its sole discretion accept the deliverable on the condition that there is compliance by the specified date; however, the City is not obligated or liable to make payment for the deliverable until such condition is satisfied.
- 30.11 In the event of any breach of this Warranty and representation, the remedies available to the City shall include but not be limited to:
- The Successful Bidder restoring the deliverable to the same level of performance as represented and warranted herein;
 - The Successful Bidder repairing or replacing the deliverable with a deliverable conforming with this representation and Warranty;
 - The Successful Bidder granting or securing for the City or its authorized agent permission to make any modifications necessary to make the deliverable compliant with this representation and Warranty and arranging for any necessary waivers of moral rights or other intellectual property rights to make such modifications; and
 - The Successful Bidder granting the City or its authorized agent access to the source code for the information technology used in the deliverable in order to make any modifications necessary to make the deliverable compliant with this representation and Warranty or securing for the City the necessary permission for such access and arranging for any necessary waivers of moral rights or other intellectual property rights to make such modifications, in each case, so as to minimize interruption to the City's ongoing business processes, with time being of the essence, and to be done at the Successful Bidder's sole expense.
- 30.12 The Successful Bidder represents and warrants that any restoration, repair or replacement made will not corrupt any data of the City or introduce any viruses into the City's system. The Successful Bidder agrees that any modification made pursuant to subparagraph 30.5 or 30.6, above, is the property of the City, including all copyright and other intellectual property rights pertaining thereto.
- 30.13 This Warranty shall survive cancellation or other termination of this contract.
- 30.14 Nothing in this representation and Warranty shall be construed to limit any rights or remedies (including indemnities) otherwise available to the City under this contract or at law or equity; and nothing in the contract shall limit the scope of this representation and Warranty and any rights or remedies set out herein, and, in particular, no waiver or disclaimer set out in such agreement (or made otherwise) shall operate to limit the Successful Bidder's liability under this representation and Warranty.

- 30.15 In the event that the Successful Bidder fails to make good such defects within a stipulated time, the City reserves the right to have the Work performed by other qualified suppliers. All costs incurred by the City are to be paid by the Successful Bidder.
- 30.16 The Successful Bidder after the date of final acceptance of all work/orders as determined by the City, or designated portion thereof, provide, in addition to the Warranty Certification a preventative Maintenance schedule for the duration of the Warranty period.
- 30.17 The Successful Bidder shall complete all manufacturer Warranty registration for applicable Products as per the Warranty Terms purchased and provide proof of registration to the City within 30 calendar days of installation.

31.0 Warranty Service

- 31.0.1 The Successful Bidder shall provide and maintain its call center telephone number(s) and call placement procedures to City of Toronto Corporate Security and the SCC for dispatching Personnel for warranty services. The telephone number(s) must be a local (Toronto) 10 digit number. The City will not accept any number that results in long distance charges for the City when placing a call from the City of Toronto.
- 31.0.2 The Successful Bidder's Call Centre telephone number(s) must be answered by a live operator and available during Daytime hours (06:00-18:00hrs, Monday through Friday), excluding statutory holidays.
- 1.0.3 The Successful Bidder must also maintain an email address for warranty service requests. Automated email responses are not acceptable.
- 6.0.4 The Successful Bidder shall provide contact lists (one list for during daytime hours and a separate list for afterhours) to ensure the required warranty service resolution times are met.

32.0 Service Calls

- 32.1.0 The technician must report to the work site, diagnose the issue and provide a corrective maintenance solution of the initial call for corrective maintenance services. The Vendor must obtain a work order from the City Designated that details the products and number of labour hours required prior to ordering Products and performing any warranty services resulting from the service call.
- 32.1.1 Upon arrival at the location, the technician must notify the Corporate Security Control Centre by phone at 416-397-0000;

32.1.2 Upon departure of the location, the technician must notify the Corporate Security Control Centre by phone at the end of each day, by email to SecSysSD@toronto.ca, and provide a required, future steps to be taken.

32.2 Service Call Resolution Times

Warranty Service Call Priority	Resolution Time
(1) Urgent	48 HOURS
(2) High	Five (5) Business Days

33.0 Pass-Through Warranties.

- 33.1 The Successful Bidder will, to the extent permissible, agrees to pass through to the City of Toronto any warranties given by its third party vendors in connection with hardware, software or other products or services used by the Successful Bidder to provide the Services to the extent permitted by the terms and conditions of such warranties and pass through to the City of Toronto all available warranties and provide all available (including extended) applicable original equipment manufacturer and additional warranties for third party Equipment used to provide the Services. The Successful Bidder will obtain and pass through to the City of Toronto any warranties required by the specifications for Equipment procured on behalf of the City of Toronto. The Successful Bidder will, to the extent permissible, pass through to the City of Toronto all available warranties and provide all available (including extended) applicable original equipment manufacturer and additional warranties for Equipment owned by the City of Toronto.
- 33.2 The Successful Bidder shall secure from the applicable Equipment or third party Software manufacturers, and assign and pass through to the City of Toronto, at no additional cost to the City of Toronto, such warranties as may be available with respect to such Equipment and Software. Such assignment shall not, however, relieve the Successful Bidder of any of the warranty obligations contained herein. In the event such warranties are not assignable to the City of Toronto, the Successful Bidder shall enforce, as necessary, such warranties on behalf of the City of Toronto.
- 33.3 In the event that Contractor purchases Goods or Materials in its own name for incorporation in the Work delivered to the City of Toronto, and the Successful Bidder receives a warranty from the vendor of such Goods or Materials, the Successful Bidder shall ensure that such warranty is passed through to, and is enforceable by, the City of Toronto.

34.0 Compliance with Standards

The Successful Bidder shall maintain a high level of workmanship and comply with the following codes, standards and procedures. Bidders that have completed and submitted the Confidentiality Agreement will be provided with copies of the City of Toronto standards listed below at the Mandatory Site Meeting.

1. City of Toronto Corporate Cabling Standards
2. City of Toronto Corporate IT Standards
3. City of Toronto Corporate Security Standards
4. City of Toronto Video Security Surveillance Policy
5. City of Toronto Corporate Security Intellex DVR Installation, Configuration, Programming and Naming Standard
6. City of Toronto Corporate Security CCTV and AV Systems Installation Standards
7. City of Toronto Corporate Security CCTV and AV Maintenance Standards
8. City's Workplace Violence Policy
9. City of Toronto Corporate Security Access Control Systems Installation Standards
10. City of Toronto Corporate Security Intercom System Installation Standards
11. City of Toronto Corporate Security Access Control and Intercom System Maintenance Standards
12. City of Toronto Corporate Security – Security Schedules – Drawing Typicals
13. City of Toronto Corporate Security Structured Cabling Standards
14. City of Toronto, Toronto Water Plant Structured Cabling System Standard
15. City of Toronto Acceptable Use Policy
16. City of Toronto CityNet Acceptable Use Agreement
17. Transport Canada Reference Manual for Using Closed Circuit Television in Counter-Terrorism Activities.
18. AC transients UL 964
19. Access Control equipment manufacturer's specifications, latest issue
20. American Society for Testing Materials (ASTM)

21. ANSI/EIA-310 and its addendum
22. ANSI/TIA/EIA-568-B.1 and its addendum
23. ANSI/TIA/EIA-568-B.3 and its addendum
24. Applicable local Building Codes
25. Association Architectural Graphic Standards for Security System Layout SIA/APSC AG-01-1995.12 (R2000.03)
26. BICSI Information Transport Systems Installation Manual – Most current Edition
27. BICSI Network Design Reference Manual – Most current Edition
28. BICSI Telecommunications Distribution Methods Manual – Most current Edition
29. Communications: IEEE RS232C and RS485
30. Canadian Standards Association (CSA International)
 - CSA C22.1-[98], Canadian Electrical Code, Part 1 (18th edition) Safety Standard for Electrical Installations.
 - CAN/CSA-C22.3 No.1-[M87 (R1997)], Overhead Systems.
31. Design: MIL 275E
32. Electrical Standards Authority
33. Electrostatic immunity: IEC 801.2 level 4
34. EMI emissions: FCC part 15
35. Institute of Electrical and Electronic Engineers (IEEE)
36. Intercom equipment manufacturer's specifications, latest issue
37. Manufacturing: ISO 9003
38. National Fire Protection Association (NFPA®)
 - NFPA® pamphlet 51B
 - NFPA® 70, National Electric Code.

- NFPA® 730, Guide for Premises Security 2008 or latest edition
- NFPA® 731, Standard for the Installation of Electronic Premises Security Systems, 2008 or latest edition

39. Ontario Building Code

40. Ontario Fire Code

41. Parks Canada - Standards and Guidelines for the Conservation of Historic Places in Canada

42. Process Control System Implementation Manual

43. Underwriters' Laboratories

- CAN/ULC-S302-M91 - Standard for Installation and Classification of Burglar Alarm Systems for Financial and Commercial Premises, safes and Vaults
- CAN/ULC-S304-06, Signal Receiving Centre and Premise Burglar Alarm Control Units.
- CAN/ULC-S317-[1996], Installation and Classification of Closed Circuit Video Equipment (CCVE) Systems for Institutional and Commercial Security Systems.
- CAN/ULC-S319-05 Electronic Access Control Systems
- CAN/ULC-S3-1-M88 Standard for Central and Monitoring Station Burglar Alarm systems.
- CAN/ULC-S524-06 – Installation of Fire Alarm Systems
- CAN/ULC-S559-04 – Equipment for Fire Signal Receiving Centres and Systems
- CAN/ULC-S561-03 – Installation and Services for Fire Receiving Centres and Systems
- UL 1076-[1995], Standard for Safety for Proprietary Burglar Alarm Units and Systems.
- UL 1635 Digital Alarm Communicator System Units
- UL 1981 Central Station Automation Systems
- UL 294-[1999], Standard for Safety for Access Control System Units.
- UL 681 Installation and Classification of Burglar and Holdup Alarm Systems
- UL Testing Bulletin
- Underwriters Laboratories (UL) Cable Certification and Follow Up Program

35.0 Manufactures List

- Aegis
- ADI
- ADT Canada
- Aiphone Corporation
- Alarm Saf
- Altronix Corporation
- Alpha Technologies
- American Dynamics
- Amseco
- Ameta International Co. Ltd.
- APC by Schneider Electric
- Arecont Vision
- Asterix Security Hardware International Inc.
- Anixer
- ASSA ABLOY Canada
- AutoGate Inc.
- Automatic Systems America Inc.
- Avigilon
- AWID
- Axis Communications, Inc.
- Berk-Tek
- Black Box Network Services
- Boon Edam, Inc.
- Bogen Communication, Inc.
- Bosch Security Systems
- Camden Door Controls
- Cansec Systems Ltd.
- CCTV Direct
- CDVI Americas Ltd.
- CDW
- Cisco Systems
- Commend Inc.
- Computar
- D-Link Canada Inc.
- Dahua Technology
- Dedicated Micros
- Detex
- Digital Watchdog
- DIRAK Inc.
- DITEK Corporation
- DoorKing Inc.

- DSC
- DWG Distribution
- Eyesonic Enterprises Inc.
- FLIR Fibre Technologies
- GAI-Tronics
- RBH Access Technologies Inc.
- RBtec Inc.
- Rofu Security International Group
- Rutherford Controls Int'l. Corp.
- Safety Technology International Inc. (STI)
- Samsung Techwin America
- Santeri Industries
- Schlage
- Schneider Electric
- Senstar Corporation
- Sentrol Inc
- Sennetech Inc.
- Sentry Security Systems
- Smart Vision Direct Inc.
- Software House
- Sony of Canada Ltd.
- Southern Folger
- Southwest Microwave, Inc.
- SPECO Technologies
- Spectris Canada Inc.
- Systech Corporation
- Talk-A-Phone
- TOA Canada Corporation
- Toppan
- Tri-Ed, an Anixter Company
- Tri Tech
- Turnstile Security Systems Inc.
- Tyco Security Products
- Ultratech
- United Security Products
- Visonic
- Von Duprin
- WatchNET Inc.
- Weiser
- Winbo International Ltd.
- Zebra

36.0 Supplementary Forms & Policies

- 1 FORM 1 – Confidentiality and Non-Disclosure Declaration
- 2 FORM 2 – Programming and Installation Standards
- 3 FORM 3 - Security Typical
- 4 FORM 4 - IP CCTV Network Cabling Guideline for City Facilities
- 5 Declaration of Compliance with Anti-Harassment/Discrimination Legislation & City Policy / Workplace Violence
- 6 Statutory Declaration (Occupational Health & Safety)
- 7 IT Acceptable Usage Policy

FORM

CONFIDENTIALITY AND NON-DISCLOSURE DECLARATION

THIS ACKNOWLEDGEMENT AND DECLARATION is given to the City of Toronto (the "City") as of the ____ day of _____, 20__ by _____ (the "Firm").

WHEREAS the Firm has elected to attend, the Mandatory Pre-bid Meeting held in connection with the City's Request for Quotations No. XXXXXX for Security Systems and services. The scope of work consists of on-demand services and the Supply/Install of City of Toronto Security Systems for various locations throughout the City of Toronto, all in accordance with the City of Toronto's Purchasing Policies and the City of Toronto Fair Wage Policy and Labour Trades Contractual Obligations in the Construction Industry.

NOW THEREFORE, in consideration of the above, the sufficiency thereof is hereby acknowledged, the Firm agrees and declares as follows:

That all information provided at the Mandatory Site Meeting is confidential and is being provided to the Firm only for the purpose of submitting a Quotation in response to the RFQ and, if successful, for the purpose of providing the services under a contract arising out of the RFQ; and

That all correspondence, documentation and information provided by the City to the Firm in connection with, or arising out of the RFQ:

- a) Is and shall remain the property of the City;
- b) Shall be treated by the Firm as confidential;
- c) Shall not be disclosed, in whole or in part, to any third party;
- d) Shall not be used for any purpose other than for replying to the RFQ, and for fulfillment of any subsequent contract arising out of the RFP.

IN WITNESS WHEREOF the Firm executes this Declaration through the signature of its duly authorized signatory.

ON BEHALF OF _____
(Name of Firm)

Signature: _____

Name: _____

Title: _____

I have the authority to bind the Firm.

FORM

**City of Toronto Programming and Installation Standards – released to successful bidder after Form 1 –
CONFIDENTIALITY AND NON-DISCLOSURE DECLARATION submitted**

FORM

City of Toronto Security Typical – released to successful bidder after FORM 1 – CONFIDENTIALITY AND NON-DISCLOSURE DECLARATION

FORM

**IP CCTV Network Cabling Guideline for City Facilities – released to successful bidder after FORM 1 –
CONFIDENTIALITY AND NON-DISCLOSURE DECLARATION**



Declaration of Compliance with Anti-Harassment/Discrimination Legislation & City Policy

Organizations/individuals in Ontario, including the City of Toronto, have obligations under the Ontario Human Rights Code, the Occupational Health and Safety Act, the Employment Standards Act, the Accessibility for Ontarians with Disabilities Act, the Criminal Code of Canada and the Charter of Rights and Freedoms. In addition, the City of Toronto also has policies that prohibit discrimination on the additional grounds of political affiliation or level of literacy, subject to the requirements of the Charter. Organizations are required to have and post policies, programs, information, instruction, plans and/or other supports, and an **appropriate** internal process available to their employees and service recipients to prevent, address and remedy discrimination, racism, harassment, hate and inaccessibility complaints under the applicable legislation and including the additional grounds of discrimination prohibited under City policy. Individuals are obliged to refrain from harassment/hate activity.

The City of Toronto requires all organizations and individuals that contract with the City to sign the following Declaration of Compliance with Anti-Harassment/Discrimination Legislation & City Policy. This Declaration must be signed by your organization and submitted with the contract or Letter of Understanding. The name of your organization and the fact that you have signed this declaration may be included in a public report to City Council.

Declaration:

I/we uphold our obligations under the above provincial and federal legislation. In addition, I/we uphold our obligations under City policies which prohibit harassment/discrimination on a number of grounds including political affiliation and level of literacy.

WHERE LEGALLY MANDATED I/we have in place the necessary policies, programs, information, instruction, plans and/or other supports that are consistent with our obligations, and I/we have an internal process available to my/our employees and service recipients to prevent, address and remedy discrimination, racism, harassment, hate and inaccessibility complaints. I/we agree that I/we shall, upon the request of the City, provide evidence of the policies, programs, information, instruction, plans and other supports and an appropriate internal complaint resolution process required under this Declaration which is sufficient to allow the City to determine compliance. I/we acknowledge that failure to demonstrate compliance with this declaration to the satisfaction of the operating Division, in consultation with the City Solicitor, may result in the termination of the contract.

Multilingual Services: 311 and TTY 416-338-0889. For further information, consult the [Equality, Diversity and Human Rights web page](http://www.toronto.ca/diversity) at <http://www.toronto.ca/diversity>

Applicant Information (Organization or Individual)

Organization Name		Position Title	
Organization Representative or Individual First Name		Organization Representative or Individual Last Name	
<input type="checkbox"/> Check this box if First Name and Last Name do not apply to you because you have either a registered Birth Certificate or Change of Name Certificate bearing a Single Name. Provide your name below.			
Single Name			
Street Number	Street Name	Suite/Unit Number	
City/Town	Province	Postal Code	Telephone Number
Organization Representative or Individual Signature			Date (yyyy-mm-dd)

43-0009 2017-08



Human Resources Policies
Workplace Violence (2019)

Category: Health and Safety

Sub-Category: General


Policy Statement

The City of Toronto is committed to working with its employees to provide a safe work environment. The City will not tolerate any acts of violence and will take all reasonable and practical measures to prevent violence and protect employees from acts of violence. Appropriate remedial, disciplinary, and/or legal action will be taken according to the circumstances.

Purpose of Workplace Violence Policy

This policy is supported by the Guidelines for Implementing the Workplace Violence Policy, a Workplace Violence and Threat Report form, a Supervisor Checklist for Workplace Violence, and an information sheet. The policy and its supporting guidelines are intended to:

1. Maintain a work environment free from workplace violence
2. Provide a definition of workplace violence
3. Identify the responsibilities of the workplace parties to maintain a workplace free of actual, attempted or threatened violence
4. Establish measures and procedures for summoning immediate assistance when workplace violence occurs or is likely to occur
5. Establish measures and procedures for workers to report incidents of workplace violence and for the City to investigate and deal with incidents or complaints immediately
6. Provide guidance to divisions on establishing their Workplace Violence program

Application

The Workplace Violence policy applies under any circumstances in which City employees experience workplace violence, as defined below. It applies to all employees, contractors of the City, volunteers, students, clients of City services, any person engaged in business with the City, and visitors to City properties.

The City's Human Rights and Anti-Harassment Policy should be consulted regarding issues of personal harassment and harassment related to discrimination and inequitable work practices.

Definitions

For the purpose of this policy, violence includes:

- the exercise of physical force by a person against a worker, in a workplace, that causes or could cause physical injury to the worker
- the exercise of physical force by a person against another person, in a workplace, that causes or could cause physical injury to the worker
- an attempt to exercise physical force against a worker that could cause physical injury to the worker
- a statement or behaviour that it is reasonable for a worker to interpret as a threat to exercise physical force against the worker, in a workplace, that could cause physical injury to the worker

The City's Human Rights and Anti-Harassment Policy addresses harassment or intimidation (e.g., behaviours that demean, embarrass, or humiliate and are known or would be expected to be unwelcome).

Responsibilities

All employees are responsible for preventing and reporting acts of violence that threaten or perceive to threaten a safe work environment.

Divisional senior management will ensure that:

- A divisional workplace violence program is established
- Reasonable preventative measures are undertaken to protect employees and others in City workplaces from workplace violence
- Take reasonable preventative measures to protect employees and others in City workplaces from workplace violence
- Ensure that a process for centralized tracking and review of workplace violence incidents is established and implemented
- Ensure that workplace violence risk assessments are completed, reviewed, revised when needed and reported
- Post this policy in a conspicuous location in each workplace
- Establish and maintain a process for reporting and responding to incidents of violence
- Ensure that the process for reporting and responding to incidents of violence is communicated, maintained and followed
- Ensure that this policy is reviewed at least annually

Managers/supervisors will:

- Understand and uphold the principles of this policy
- Communicate this policy and its guidelines to all employees
- Conduct workplace violence risk assessments to determine whether the nature of the workplace, the type of work or conditions of work may place employees at risk of violence
- Consult with Joint Health & Safety Committees (JHSCs)/OHS Representatives, assigned People, Equity & Human Rights (PEHR) /divisional health & safety staff, and where appropriate, Corporate Security, in conducting risk assessments, and develop practical measures and procedures to control identified risks
- Take all reasonable and practical measures to minimize or eliminate risks identified through the risk assessment process, workplace inspections, or the occurrence of a workplace violence incident
- Review risk assessments at least annually, as well as when there are changes to the nature of the workplace, the type of work or the conditions of work. Revise the assessment, as needed
- Conduct further risk assessments when an increase in the number or severity of workplace violence incidents is noted to ensure that appropriate measures are in place to minimize or eliminate risks
- Communicate the results of workplace violence risk assessments and measures to minimize or eliminate risks to staff.
- Provide results of risk assessments (initial and updated) to joint health and safety committees/health and safety representatives
- Maintain and follow the process in the City's *Investigation and Reporting of Work-Related Injuries and Incidents* policy for reporting, investigating, documenting, and debriefing incidents of violence
- Respond promptly when an employee reports being subjected to, witnessing, having knowledge of workplace violence or having reason to believe that workplace violence may occur and take appropriate action.
- Address immediately all incidents of workplace violence, and not condone or permit any behaviour contrary to this policy. Exceptions to this must be clearly defined in the divisional procedures, describing specific behaviours that are unacceptable (e.g., unacceptable behaviours among a specific client group such as young children or clients with developmental, cognitive, or psychiatric disabilities). This exception must be communicated to staff but must not

condone behaviours contrary to this policy.

- Ensure that all known incidents of workplace violence are investigated. To the extent appropriate based on the nature of each incident and the actual or potential threat it posed to worker safety:
 - consult with other parties (e.g., Corporate Security, Health & Safety staff, JHSCs/OHS Representatives, Employee Health and Rehabilitation, Employee Assistance Program, Human Rights Office, Toronto Police Services)
 - take all reasonable and practical measures to minimize or address risks identified by the incident
 - document the incident, its investigation, and corrective action taken
 - promptly share the results of the investigation and corrective actions taken with the joint health and safety committee/health and safety representative and the workers involved in the incident
- Ensure workers are made aware of their rights to:
 - have workplace violence incidents investigated when they are reported
 - report incidents of physical assault or threats of physical assault to the police
 - support from management when reporting incidents of physical assault or threats of physical assault to the police (e.g. time for interactions with the police and making accessible to the police information in the employer's possession with respect to the incident)
- Take all reasonable and practical measures to protect workers, acting in good faith, who report workplace violence or act as witnesses, from reprisal or further violence
- Take every precaution reasonable in the circumstances for worker protection if they become aware, or ought reasonably to be aware, that domestic violence that would likely expose a worker to physical injury may occur in the workplace
- Review annually, in conjunction with review of risk assessments, the effectiveness of actions taken to minimize or eliminate workplace violence and make improvements to divisional procedures, as required
- Provide information to workers, including appropriate personal information, related to a risk of workplace violence from a person with a history of violent behaviour
- Provide workers with information and instruction appropriate for the worker on the City's workplace violence policy and program

People, Equity & Human Rights (PEHR)/ Divisional Occupational Health and Safety staff will:

- Assist management to implement this policy, develop divisional procedures, and initiate the annual review of the policy and guidelines

Joint Health and Safety Committees/OHS Representatives will:

- Review the Workplace Violence Risk Assessment results and provide recommendations to management to reduce or eliminate the risk of violence
- Review all reports forwarded to the JHSC regarding workplace violence and other incident reports as appropriate pertaining to incidents of workplace violence that result in personal injury or threat of personal injury, property damage, or police involvement
- Participate in the investigation of critical injuries (e.g., incidents that place life in jeopardy, result in substantial blood loss, fracture of leg or arm, etc.)

- Recommend corrective measures for the improvement of the health and safety of workers
- Respond to employee concerns related to workplace violence and communicate these to management
- Participate in the review of the policy and guidelines for continuous improvement

In addition, JHSCs/OHS Representatives may participate in the investigation of reported incidents that result in personal injury or have the potential to result in injury.

The Occupational Health and Safety Coordinating Committee will:

- Review annually the effectiveness of the policy and guidelines and make changes as required by consulting with management staff and employee representatives

All employees will:

- Maintain a safe work environment, whenever possible
- Not engage in or ignore violent, threatening, intimidating or other disruptive behaviours
- Report promptly and provide details to their supervisor (or the appropriate alternative listed in the attached guidelines) any incident where the employee is subjected to, witnesses, or has knowledge of workplace violence, or has reason to believe that workplace violence may occur

Reprisal

This policy prohibits reprisals against individuals, acting in good faith, who report incidents of workplace violence or act as witnesses. Management will take all reasonable and practical measures to prevent reprisals, threats of reprisal, or further violence. Reprisal is defined as any act of retaliation, either direct or indirect.

Authorities

Occupational Health and Safety Act of Ontario (current)
Criminal Code of Canada (current)
City of Toronto Corporate Occupational Health and Safety Policy (reviewed annually)

Previous Versions

February 18, 2002
 March 25, 2010
 February 28, 2012
 December 5, 2012
 September 18, 2014
 February 10, 2016
 December 6, 2016
 September 27, 2017
 OHSCC-endorsed and City Manager-approved

Endorsed by:

Occupational Health and Safety Coordinating Committee (OHSCC), October 30, 2001
 Reviewed and re-endorsed by OHSCC, December 12, 2018

Guidelines

Guidelines for Implementing the Workplace Violence Policy

Effective

January 1, 2019 - December 31, 2019

Approved by	City Manager
Date Approved	February 4, 2013
Reviewed and re-approved by OHSCC	December 12, 2018
Related information	Human Rights and Anti-Harassment/Discrimination Policy City of Toronto Corporate Occupational Health and Safety Policy Investigation and Reporting of Work-Related Injuries and Incidents Policy Guidelines for Implementing the Workplace Violence Policy
Related links - external	The Occupational Health and Safety Act of Ontario Criminal Code of Canada

[Go back](#)



RFQ «QuotationRequestNumber»

STATUTORY DECLARATION
(Occupational Health & Safety)

PROVINCE OF ONTARIO)
JUDICIAL DISTRICT OF YORK)

IN THE MATTER OF RFQ NO. _____ AND ANY ENSUING CONTRACT
BETWEEN

(Company Name)

- AND -

City of Toronto

I, _____ of the City/Town/Village of _____ in the
Province
(Name)

of _____ do solemnly declare the following:
(Name of Province)

1. I am the _____ of the _____ and as such
(Insert Title) (Insert Company Name)

have knowledge of the matters herein stated.

2. _____ is a sole proprietorship/partnership/corporation with its head office
(Company Name)
located at _____ and has carried on business as
a _____ (contractor/state other type of
business)
since on or about _____
(Insert Date)

3. _____ since _____ had in place a Health and Safety
Policy
(Company Name) (Insert Date)

under Section 25(2) (j) of the *Occupational Health and Safety Act*, R.S.O. 1990, c. 0.1 as amended, (the "Act")
and

has/have developed and maintain(s) on an annual basis a program to implement the written Occupational Health
and Safety

Policy. A copy of the policy and program for _____ (Insert Company Name) will be
delivered to the

City of Toronto upon request by the City and will be available for inspection at the City of Toronto, solely for the
purposes of



the above noted Contract.

4. _____ since _____ had in place a Workplace Violence and a
(Company Name) (Insert Date)

Workplace Harassment Policy under Section 32.0.1(1) of the *Occupational Health and Safety Act*, R.S.O. 1990, c. 0.1 as amended, (the "Act") and has/have developed and maintain(s) on an annual basis a program to implement the written Workplace Violence and Workplace Harassment Policy. A copy of the policy and program for _____ (Insert Company Name) will be delivered to the City of Toronto upon request by the City and will be available for inspection at the City of Toronto, solely for the purposes of the above noted Contract.

5. _____ (Insert Company Name) will employ for the Work under this Contract a supervisor or supervisors who are competent persons as defined by section 1(1) of the Act, and specifically a person or persons who:

- (a) are qualified because of knowledge, training and experience to organize the Work and its performance;
- (b) are familiar with the Act and the regulations made thereunder that apply to the Work; and
- (c) have knowledge of any potential or actual danger to health and safety associated with the Work.

6. _____ (Insert Company Name) will employ for the purpose of

this project the following competent supervisors:

(Insert name of supervisors)

No supervisors other than those named shall work on this Contract.

7. The supervisors employed by _____ (Insert Company Name) has successfully completed the necessary health and safety courses to be considered a competent person to undertake the Work described in the Contract.

AND I/We make this solemn Declaration conscientiously believing it to be true, and knowing that it is of the same force and

effect as if made under oath and by virtue of "The Canada Evidence Act".

DECLARED BEFORE ME AT THE

OF

IN THE

THIS DAY OF 20__

A Commissioner etc.

)
)
)
)
) _____
) Signing Officer for Company
)
)
)

City of Toronto

Acceptable Use of Information Technology Assets Policy

1. Policy Statement

- 1.1 The City of Toronto provides Authorized Users with access to the City's Information Technology Assets to be used for the purpose of conducting legitimate business activities and advancing the goals and objectives of the City of Toronto.
- 1.2 This Policy establishes principles and requirements for the acceptable use of the City's Information Technology Assets.

2. Definitions

- 2.1 **Accountability Officer(s)** refers to the Auditor General, Integrity Commissioner, Lobbyist Registrar and the Ombudsman at the City of Toronto.
- 2.2 **Authorized Users** are all individuals who have been granted access to the City's Information Technology Assets. This includes, but is not limited to, employees, consultants, contractors, subcontractors, individuals on secondment to the City, students and volunteers at the City of Toronto and Accountability Officers and anyone working or volunteering for or in their Offices subject to Section 3-10 F(5), Chapter 3, Accountability Officers, of the Toronto Municipal Code.
- 2.3 **Confidential Information** includes, but is not limited to, privileged information, draft by-laws or staff reports, third party information, personal information, technical or financial or scientific information and any other information collected, obtained or derived for or from City records that must or may be kept confidential under the *Municipal Freedom of Information or Privacy Act*, the *Personal Health Information Protection Act, 2004* or the *City of Toronto Act, 2006*.
- 2.4 **Information Technology Assets** are any system, service, hardware, and network assets that are owned by or supplied to Authorized Users by the City. This includes, but is not limited to, desktop computers, monitors, printers, notebooks, mobile devices, digital projectors, scanners, storage devices, networks and network devices, software, internet access, email, communication and business applications, telephones and voice mail, facsimile machines, and photocopiers.
- 2.5 **Systems Monitoring** refers to monitoring the City's Information Technology Assets used by Authorized Users for the collection and review of aggregate,

broad-based, or statistical data to assess, maintain, update or ensure reliability, security, confidentiality and integrity of City's Information Technology Assets. Systems monitoring is not directed at an identifiable individual(s).

- 2.6 **User Monitoring** refers to recording, accessing and reviewing or analyzing one or more identified Authorized User's activity on, or use of, the City's Information Technology Assets.

3. Application

- 3.1 This Policy applies to all Authorized Users with access to any of the City's Information Technology Assets.
- 3.2 Accountability Officers are responsible for the application of and compliance with this Policy in their Offices, including user monitoring where required, pursuant to Chapter 3, Accountability Officers, of the Toronto Municipal Code.
- 3.3 Exceptions
 - 3.3.1 This Policy does not apply to Members of Council or anyone working or volunteering for or in their offices. Council Members are governed by the Code of Conduct for Members of Council, the Human Resources Management and Ethical Framework for Members' Staff, and applicable City policies and protocols.

4. Principles

- 4.1 The City's Information Technology Assets are corporate resources and are to be used in accordance with this Policy and other applicable City of Toronto by-laws, policies and relevant federal and provincial legislation.
- 4.2 Authorized Users shall exercise good judgment and responsibility when using the City's Information Technology Assets.
- 4.3 The City's Information Technology Assets shall be used in an ethical and professional manner.
- 4.4 The City's Information Technology Assets will be used in a manner that safeguards the integrity, privacy and confidentiality of the City's assets, information, and data.
- 4.5 Authorized Users are responsible for their use of the City's Information Technology Assets at all times, including non-business hours.

- 4.6 Authorized Users shall not expect absolute privacy when using the City's Information Technology Assets, including such limited personal use as permitted in accordance with Section 7 of this Policy.
- 4.7 Authorized Users shall not have any expectation that any use of City's Information Technology Assets, including limited personal use, is exempt from Systems Monitoring and/or User Monitoring in accordance with this Policy.
- 4.8 Each Authorized User's Manager or Supervisor shall ensure that the Authorized User is aware of and understands their role and responsibility under this Policy and related City by-laws, policies and relevant provincial and federal legislation.

5. User Accountability and Responsibility

5.1 Security

- 5.1.1 Authorized Users are to exercise good judgment and reasonable care in protecting Information Technology Assets from theft, damage or illegal access and against systems designed to disrupt, damage or place excessive load on the assets.
- 5.1.2 Authorized Users are responsible for safeguarding, protecting, and not sharing password(s) used to access the City's Information Technology Assets.
- 5.1.3 Any breach to the security of City's information technology systems or damage to or loss of Information Technology Assets will be immediately reported by the Authorized User to the I&T Service Desk and their Supervisor/Manager.

5.2 Information Management

- 5.2.1 All Authorized Users are responsible for the proper management of information in accordance with related provincial and federal legislation, and City of Toronto by-laws and policies referenced in Section 11 of this Policy.
- 5.2.2 Authorized Users must protect confidential information that belongs to the City, its service users, residents, partners or vendors, in accordance with the requirements of relevant provincial, and federal legislation, contractual restrictions, and related City of Toronto by-laws, and policies.

- 5.2.3 When conducting City business, Authorized Users are responsible for maintaining an accessible record and information in accordance with City by-laws, policies and relevant provincial and federal legislation.
- 5.2.4 All information, records and data related to City business and created or legally acquired using the City's Information Technology Assets must be stored on the City's network server or on an Information Technology Asset owned or under contract to the City.
- 5.2.5 Authorized Users are encouraged not to use system, service, hardware, and network assets not owned by or supplied by the City for the performance of the Authorized User's duties and responsibilities. Authorized Users shall not, under any circumstances, use any system, service, hardware, and network assets not owned by or supplied by the City for the performance of the Authorized User's duties and responsibilities where such use:
 - 5.2.5.1 compromises the security of the City's Information Technology Assets;
 - 5.2.5.2 results in a breach of provincial or federal legislation, or of the City of Toronto by-laws and policies referenced in Section 11 of this Policy;
 - 5.2.5.3 results in the release of confidential information that belongs to the City, its service users, residents, partners or vendors, contrary to the requirements of relevant provincial and federal legislation contractual restrictions, or related City of Toronto by-laws and policies; and/or
 - 5.2.5.4 results in the City incurring any unauthorized costs associated with Authorized Users accessing the City's network remotely.
- 5.2.6 Authorized Users who elect to use system, service, hardware, and network assets not owned by or supplied by the City for the performance of the Authorized User's duties and responsibilities may, through such use, make the system, service, hardware, and network assets used for this purpose subject to provincial and federal access to information legislation contractual restrictions, and related City of Toronto by-laws and policies, and shall cooperate with the City in fulfilling any resultant obligations that arise from such use.
- 5.2.7 Authorized Users who elect to use system, service, hardware, and network assets not owned by or supplied by the City for the performance

of the Authorized User's duties and responsibilities shall ensure that information, records, and data created, accessed, acquired, managed, or reviewed through such use is moved to and stored on the City's Information Technology Assets at the first available opportunity, following which it is deleted from the system, service, hardware, and network assets not owned by or supplied by the City.

5.3 Remote Access

- 5.3.1 Authorized Users with remote access to the City's network must connect using authorized methods and systems and ensure that the Information Technology Asset or the system, service, hardware, and network assets not owned by or supplied by the City is safe to use and will not negatively impact the City's network.
- 5.3.2 Authorized Users must maintain the privacy, confidentiality and integrity of corporate business information accessed through remote access.
- 5.3.3 All corporate information produced, accessed, or altered through remote access must be stored on the City's network or on an Information Technology Asset owned or under contract to the City.
- 5.3.4 The City will not incur any unauthorized costs associated with Authorized Users accessing the City's network remotely.
- 5.3.5 The City retains the right to terminate Authorized Users' remote access at any time.

6. Ownership

6.1 Assets

- 6.1.1 The City's Information Technology Assets are the sole property of the City of Toronto.
- 6.1.2 All Authorized Users must provide, when requested by management or delegated staff, any Information Technology Asset.

6.2 Information and Records

- 6.2.1 All information and records created or legally acquired using the City's Information Technology Assets are the sole property of the City of Toronto with the exception of records which arise from the permitted

personal use of Information Technology Assets in accordance with Section 7.

7. Personal Use

- 7.1 Reasonable and limited personal use of Information Technology Assets is permitted, provided that it:
 - 7.1.1 Does not interfere with the Authorized User's duties and responsibilities.
 - 7.1.2 Is lawful and in compliance with applicable City of Toronto by-laws and policies, and relevant federal or provincial legislation.
 - 7.1.3 Does not compromise the security of the City's Information Technology Assets.
 - 7.1.4 Is not used for private gain, whether monetary or non-monetary, or advancement or the expectation of private gain.
 - 7.1.5 Does not result in the City incurring an expense unless it is incurred in accordance with the Business Expense Policy.
- 7.2 Authorized Users are responsible for properly managing personal files. The City is not liable nor will it incur any expense to protect or back-up personal files.
- 7.3 Authorized Users are encouraged to not store their own personal information or personal files on the City's Information Technology Assets. Users that elect to store their own personal information or personal files acknowledge that they are doing so at their own risk.

8. Unacceptable Use of Information Technology Assets

- 8.1 Unacceptable use of the City's Information Technology Assets includes, but is not limited to:
 - 8.1.1 Using the City's Information Technology Assets to access or carry out any activities that are obscene, lewd, or pornographic.
 - 8.1.2 Using the City's Information Technology Assets to carry out any activities that are harassing, embarrassing, discriminatory or defamatory to another individual, employee, or group, or that are in breach of the employee's duty of fidelity to the City of Toronto.

- 8.1.3 Using Information Technology Assets to carry out any activities that contravene federal, provincial legislation and City of Toronto by-laws and policies.
- 8.1.4 Activities that will interfere with the normal operations of the City's Information Technology Assets, including intercepting or altering information transmitted.
- 8.1.5 Violating terms of applicable software licensing agreements or intellectual property laws, including installing software without a license.
- 8.1.6 Disclosing or distributing confidential information without authorization or contrary to City policies and by-laws and relevant federal or provincial legislation.
- 8.1.7 Circumventing the City's security schemes and protection.
- 8.1.8 Unauthorized use, infringement, theft, reconfiguration, movement, or relocation of City's Information Technology Assets and/or data, information or records located on the City's Information Technology Assets.

9. Monitoring

9.1 Systems Monitoring

- 9.1.1 The City of Toronto has the right to conduct Systems Monitoring at any time, at will and in its sole discretion, including the right to filter and quarantine both inbound and outbound content, as may be necessary to protect the integrity, security, confidentiality, or reliability of the City's Information Technology Assets.
- 9.1.2 As part of System Monitoring, the City of Toronto may recover deleted files and data stored or accessed using the City's Information Technology Assets.

9.2 User Monitoring

- 9.2.1 The City of Toronto reserves the right, but does not have a duty, to conduct User Monitoring.
- 9.2.2 The City may exercise its right to perform User Monitoring:

9.2.2.1 If in the opinion of the City Solicitor there are reasonable grounds and/or a reasonable belief based on credible information received to support User Monitoring, including but not limited to information or belief that:

- i. An Authorized User is violating this Policy or other City of Toronto by-laws and policies, or any relevant federal and provincial legislation in their use of the City's Information Technology Assets.
- ii. An Authorized User is using the City's Information Technology Assets in a fashion incompatible with the User's employment with the City or grant of access to the City's Information Technology Assets.
- iii. The results from general Systems Monitoring provide reasonable grounds to focus on and review a specific Authorized User's activity.

9.2.2.2 In the alternative, if necessary to:

- i. protect and maintain the City's Information Technology Assets or other assets and interests from an immediate or imminent threat.
- ii. support the City of Toronto's efforts to comply with legal requirements, or defend itself in proceedings.

9.2.2.3 For other legitimate business, corporate or human resources purposes, including as a result of the absence of an employee.

9.2.3 User Monitoring pursuant to Section 9.2.2, User Monitoring, will be conducted in accordance with the User Monitoring Procedures referenced in Section 11.1.11, and the following principles:

9.2.3.1 If effective alternatives to User Monitoring are available in identifying inappropriate use or responding to a legitimate business, corporate, or human resources purpose, they shall be employed.

9.2.3.2 The least intrusive but effective means of User Monitoring shall be used.

- 9.2.3. Results of User Monitoring shall remain confidential, subject to the requirements of the investigation (including matters arising from the investigation), and/or other City by-laws, policies and relevant provincial and federal legislation.
- 9.2.3.4 Any decision to prosecute or refer User Monitoring or investigation results to the Toronto Police Service or other regulatory agencies for independent investigation will be made in accordance with the Toronto Public Service By-law, Chapter 192, Public Service of the Toronto Municipal Code.
- 9.2.4 User Monitoring by any individual for private or personal interest, curiosity, or without cause and appropriate authorization is prohibited and shall be considered a violation of this Policy.
- 9.3 Section 9.2 of this Policy does not apply to Accountability Officers when user monitoring is necessary as part of the fulfillment of their statutory mandate and responsibilities under Part V of the *City of Toronto Act, 2006*.
 - 9.3.1 In circumstances, where an Accountability Officer is conducting user monitoring for their own Office or their staff, the Accountability Officer is responsible for applying Section 9.2 as deemed appropriate by the Accountability Officer.

10. Compliance

- 10.1 Failure to comply with this Policy may result in disciplinary action up to and including dismissal and/or legal proceedings where warranted.
- 10.2 In an event of a conflict or difference the federal and provincial legislation supersedes this Policy.
- 10.3 This Policy supersedes other City or divisional policies, standards and guidelines that govern the use of Information Technology Assets in an event of conflict or difference, subject to the principle that specific provisions of the other policies, standards, and guidelines continue to apply despite a more general provision being set out in this Policy.
- 10.4 This Policy shall be reviewed every three to five years and the City reserves the right to amend this Policy at any time.

11. Related By-laws, Policies and Procedures

- 11.1 This Policy is to be implemented and interpreted with other related by-laws and policies, including:
- 11.1.1 Toronto Municipal Code, Chapter 192, Public Service
<http://www.toronto.ca/legdocs/municode/toronto-code-192.pdf>
 - 11.1.2 Application of City Policies to Social Media Use:
http://insideto.toronto.ca/social_media/pdf/socialmediause.pdf
 - 11.1.3 City of Toronto Human Rights and Anti-Harassment/Discrimination Policy:
[Human Rights and Anti-Harassment/Discrimination Policy](#)
 - 11.1.4 Corporate Information Security Policy:
http://insideto.toronto.ca/itweb/policiesstandards/information_security.htm
 - 11.1.5 IT Asset Management Policy:
<http://insideto.toronto.ca/itweb/policiesstandards/pdf/asset-management.pdf>
 - 11.1.6 Toronto Municipal Code, Chapter 3, Accountability Officers
http://www.toronto.ca/legdocs/municode/1184_003.pdf
 - 11.1.7 Toronto Municipal Code, Chapter 217, Records, Corporate (City)
[Toronto Municipal Code, Chapter 217](#)
 - 11.1.8 Business Expense Policy
http://insideto.toronto.ca/accounting_services/pdf/business_expense_policy.pdf
 - 11.1.9 Information Management Accountability Policy
<https://www.toronto.ca/wp-content/uploads/2018/07/8ec6-information-management-accountability-policy.pdf>
 - 11.1.10 Protection of Privacy Policy
<https://www.toronto.ca/wp-content/uploads/2017/08/9023-ProtectionOfPrivacyFinalAODA.pdf>
 - 11.1.11 User Monitoring Procedures
<http://insideto.toronto.ca/itweb/policy/pdf/user-monitoring-procedures.pdf>

Approved By:
Peter Wallace
City Manager
February 26, 2018

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section includes requirements for rough grading.

1.2 RELATED REQUIREMENTS

- .1 Section 31 23 33.01 Excavating, Trenching and Backfilling
- .2 Section 31 32 19 Geosynthetics
- .3 Section 32 11 23 Aggregate Base Courses
- .4 Section 33 41 16 Subdrainage Piping

1.3 EXISTING CONDITIONS

- .1 Review soil report if applicable.
- .2 Known underground and surface utility lines and buried objects are as indicated on site plan.
 - .1 Contractor is responsible to obtain utility locations prior to commencing works.
- .3 Refer to dewatering requirements in Section 31 23 33.01 Excavating, Trenching and Backfilling.

PART - 2 PRODUCTS

2.1 MATERIALS

- .1 Fill material: provide in accordance with of Section 31 23 33.01 Excavating, Trenching and Backfilling.
- .2 Excavated or graded material existing on site suitable to use as fill for grading work if accepted by Consultant.

PART - 3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate as exist or as previously installed under other Sections or Contracts are acceptable for rough grading installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written notice to proceed from Consultant and Owner.

3.2 STRIPPING OF TOPSOIL

- .1 Refer to Section 31 23 33.01 Excavating, Trenching and Backfilling.

3.3 GRADING

- .1 Rough grade to levels, profiles, and contours allowing for surface treatment as indicated.
- .2 Ensure positive drainage away from buildings, structures and paved areas.
- .3 Grade ditches to depth as indicated.
- .4 Prior to placing fill over existing ground, scarify surface to depth of 150 mm minimum. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.

- .5 Compact filled and disturbed areas to maximum dry density, as follows:
 - .1 85% under landscaped areas.
 - .2 98% under paved areas.
- .6 Do not disturb soil within designated tree protection areas.
 - .1 Where permitted, disturbance within tree protection areas shall be supervised by a qualified arborist.
 - .2 Roots or branches may be cut only by a qualified tree care professional, and in full compliance with the City Policy.

3.4 TOLERANCES

- .1 Rough grade surface to be parallel with finished surface. Slopes shall not deviate from finished slopes.
- .2 Surface to be generally smooth with localized deviations not to exceed 50 mm from required elevations.
- .3 Any areas found to be graded incorrectly or outside of tolerances shall be regraded promptly to Owner and Consultant's satisfaction.

3.5 TESTING

- .1 Inspection and testing of soil compaction will be carried in accordance with Section 01 45 00 - Quality Control.

3.6 PROTECTION

- .1 Protect all existing items which are to remain. If damaged, restore to original or better condition unless directed otherwise.
- .2 Maintain access roads to prevent accumulation of construction related debris on roads.

END OF SECTION 31 22 13

PART - 1 GENERAL

1.1 SUMMARY

- .1 This Section includes requirements for excavating, trenching and backfilling for structures, pavements, pipe-lines, sewers, conduits and appurtenances.

1.2 RELATED REQUIREMENTS

- .1 Section 31 22 13 Rough Grading.
- .2 Section 31 32 19 Geosynthetics
- .3 Section 32 11 23 Aggregate Base Courses
- .4 Section 33 41 16 Subdrainage Piping

1.3 SOIL REPORT

- .1 Will be provided separately.

1.4 MEASUREMENT PROCEDURES

- .1 The following apply only to extra work.
- .2 Excavated materials will be measured in cubic metres in their original location.
- .3 Excavation quantities measured will be actual volume removed within following limits:
 - .1 Width for trench excavation as indicated.
 - .2 Width for excavation for structures as indicated.
 - .3 Depth from ground elevation immediately prior to excavation, to elevation as indicated or required to install the work.
- .4 Shoring, bracing, cofferdams, underpinning and de-watering of excavation will not be measured separately.
- .5 Backfilling to authorized excavation limits will be measured in cubic metres compacted in place for each type of material specified.
- .6 Placing and spreading of topsoil will be measured in square metres.

1.5 REFERENCE STANDARDS

- .1 Reference to the listed standards shall be considered to include related standards and documents or standards referenced within the listed documents.
- .2 City of Toronto Engineering and Technical Services (ECS) Standard Specifications (TS):
 - .1 TS 1010 Amendment to Aggregates – Base, Subbase, Select Subgrade, and Backfill Material
- .3 Ontario Provincial Standard Specifications (OPSS):
 - .1 OPSS MUNI 1001 Aggregates – General
 - .2 OPSS MUNI 1004 Aggregates – Miscellaneous
 - .3 OPSS MUNI 1010 Aggregates – Base, Subbase, Select Subgrade, and Backfill Material
 - .4 OPSS MUNI 1359 Unshrinkable Backfill

1.6 DEFINITIONS

- .1 Topsoil:
 - .1 Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.

- .2 Material reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and free from cobbles, stumps, roots, and other objectionable material larger than 25 millimeters in any dimension.
- .2 Waste material: excavated material unsuitable for use in Work or surplus to requirements.
- .3 Borrow material: material obtained from locations outside area to be graded and required for construction of fill areas or for other portions of Work.
- .4 Recycled fill material: material, considered inert, obtained from alternate sources and engineered to meet requirements of fill areas.
- .5 Unsuitable materials:
 - .1 Weak, chemically unstable, and compressible materials.
 - .2 Frost susceptible materials:
 - .3 Coarse grained soils containing more than 20% by mass passing 0.075 mm sieve.
- .6 Unshrinkable fill: very weak mixture of cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

1.7 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Quality Control: in accordance with Section 01 45 00 - Quality Control:
 - .1 Inform Owner and Consultant at least 4 weeks prior to beginning Work, of proposed source(s) of fill, aggregates, unshrinkable fill and any other materials to be used for the work.
 - .1 Provide source documentation of materials to be supplied including standard testing showing compliance with relevant OPSS requirements. Testing to have been completed within 1 calendar year of date of submittal.
 - .2 Where documentation is not available for any reason, Contractor shall arrange and pay for testing to be carried out by the same third-party contracted by the Owner or Consultant for Quality Assurance.
 - .2 Other submittals may be required due to unexpected conditions or as a result of the Contractors chosen work method (i.e. dewatering or heave prevention methods).
- .3 Preconstruction Submittals:
 - .1 Submit records of underground utility locates indicating location of existing utilities as found in field or clearance record from utility owner.

1.8 QUALITY ASSURANCE

- .1 Do not import any soil or aggregate material until written acceptance of submittals is provided by the Owner or Consultant.
- .2 Coordinate with the designated testing and inspection company to ensure all required sampling and testing may be carried out. Refer to section 01 45 00.
 - .1 The Work and materials shall be accessible to the third-party testing and inspections company at all times.
 - .2 Where sampling or testing have not been completed, the Contractor shall not carry on with subsequent work that would render such areas inaccessible, except with written notice to proceed from Owner or Consultant.

1.9 EXISTING CONDITIONS

- .1 Examine soil report as attached.
- .2 Buried services:

- .1 Before commencing work verify location of buried services on and adjacent to site.
- .2 Arrange with appropriate authority for relocation of buried services that interfere with execution of work: pay costs of relocating services.
- .3 Remove obsolete buried services encountered during excavations to minimum 1 m from the finished work or as directed by Owner or Consultant.
- .4 Size, depth and location of existing utilities and structures as indicated on the drawings are for guidance only. Completeness and accuracy are not guaranteed.
- .5 Confirm locations of buried utilities by careful test excavations or soil hydrovac methods, if required by the utility owner.
- .6 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered or as indicated.
- .7 Record location of maintained, re-routed and abandoned underground lines encountered during the work.
- .8 Confirm locations of recent excavations adjacent to area of excavation.
- .3 Existing buildings and surface features:
 - .1 Contractor is responsible for condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks, pavement, survey benchmarks and monuments which may be affected by Work.
 - .2 Protect existing buildings and surface features from damage while Work is in progress. In event of damage, immediately make repair as directed by Owner or Consultant.
 - .3 Where permitted, roots or branches may be cut only by a qualified tree care professional, and in full compliance with the City Policy.

1.10 REQUIREMENTS UNDER ONTARIO REGULATION 406/19 ON-SITE AND EXCESS SOIL MANAGEMENT

- .1 The Work has been designed in a manner such that export of soil from the property shall not be required and that no applicable requirements of the regulation shall need apply to the work.
 - .1 If site conditions change or if site conditions not known at time of tender affect the feasibility of on-site soil retention, the Contractor shall notify the Owner and Consultant immediately and await direction.
 - .2 If the Contractor elects to export soil materials from the site for any reason, any applicable requirements of the Regulation shall be met by the Contractor at their own cost, to the Owner's satisfaction.
 - .1 Any costs borne by the Owner as a result of such action on the Contractor's part shall be recoverable in accordance with the Contract terms.

PART - 2 PRODUCTS

2.1 MATERIALS

- .1 General:
 - .1 Materials shall conform to OPSS and standards referenced therein.
- .2 Aggregates:
 - .1 All aggregates used for the work shall conform to TS 1010 / OPSS 1010, except as noted.
 - .2 Where not specified, any reference to Granular 'B' shall be read as a reference to Granular 'B' Type II only.

- .3 Re-claimed Concrete Material (RCM), re-claimed asphalt, and slag of any type SHALL NOT BE USED without express written authorization by the Owner or Consultant.
- .3 Clear Stone and Rip-rap stone shall comply with OPSS 1004
- .4 Unshrinkable Backfill shall comply with OPSS 1359.
- .5 High Performance Bedding shall consist of washed, angular limestone particles of uniform 7 mm size.
- .6 Geosynthetics:
 - .1 Refer to Section 31 32 19
- .7 Other materials as may be required for a complete installation shall be selected by the Contractor and subject to review by Consultant and Owner.

PART - 3 EXECUTION

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until removal.
- .3 Remove erosion and sedimentation controls only when directed to do so by Owner or Consultant.
 - .1 Restore and stabilize areas disturbed during removal.

3.2 SITE PREPARATION

- .1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.
- .2 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly. Refer to Section 02 41 13 - Site Demolition.

3.3 PREPARATION/PROTECTION

- .1 Protect existing features in accordance with Section 01 56 00 - Temporary Barriers and Enclosures and applicable local regulations.
- .2 Keep excavations clean, free of standing water, and loose soil.
- .3 Where soil is subject to significant volume change due to change in moisture content, cover and protect to Consultant and Owner's satisfaction.
- .4 Protect natural and man-made features required to remain undisturbed.
- .5 Protect existing trees from damage.
- .6 Protect buried services that are required to remain undisturbed.

3.4 STRIPPING OF TOPSOIL

- .1 Do not handle topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected as determined Consultant.
- .2 Begin topsoil stripping after area has been cleared of rocks over 50 mm, all vegetation including invasive and noxious plants and their reproductive parts and after all of the above have been removed from the site.
 - .1 Rototill vegetation to retain as component of topsoil only if instructed on drawings or in writing by Consultant.
- .3 Strip topsoil to full depth, or to depths as may be indicated.

- .1 Do not mix topsoil with subsoil.
- .2 Where depth of topsoil encountered varies from that indicated in the soil report, Contractor shall immediately inform Consultant and Owner.
- .4 Stockpile in locations agreed with Owner and Consultant.
 - .1 Stockpile height not to exceed 2 m
 - .2 Stockpile to be protected from erosion, adverse weather conditions, contamination from invasive plant material, and compaction.
 - .3 Avoid placing stockpile in low areas where natural drainage or storm water could pond or erode these materials during inclement weather.
- .5 Dispose of unused topsoil legally off-site.

3.5 STOCKPILING

- .1 Stockpile fill materials in areas designated by Owner and Consultant.
 - .1 Stockpile granular materials in manner to prevent segregation.
- .2 Protect fill materials from contamination.
- .3 Implement sufficient erosion and sediment control measures to prevent sediment release off construction boundaries and into water bodies.

3.6 SHORING

- .1 Maintain sides and slopes of excavations in safe condition by appropriate methods and in accordance with the Ontario Occupational Health and Safety Act.
- .2 Where measures such as shoring, bracing or the like may be required, inform the Owner and Consultant prior to commencing the work.
- .3 Where conditions are or become unstable, the Contractor shall take such measures as are necessary to protect safety of employees and the public and shall inform the Owner and Consultant immediately.

3.7 DEWATERING AND HEAVE PREVENTION

- .1 Keep excavations free of water while Work is in progress.
- .2 Where required, provide for details of proposed dewatering or heave prevention methods, for Owner and Consultant's review.
- .3 Avoid excavation below groundwater table if quick condition or heave is likely to occur.
 - .1 Prevent piping or bottom heave of excavations by groundwater lowering, sheet pile cut-offs, or other means.
- .4 Protect open excavations against flooding and damage due to surface run-off.
- .5 Dispose of water in to approved areas only and in manner not detrimental to public and private property, or portion of Work completed or under construction.
 - .1 Provide and maintain temporary drainage ditches and other diversions outside of excavation limits within work area.
- .6 Provide treatment to remove suspended solids or other materials before discharging to storm sewers, watercourses or drainage areas.

3.8 EXCAVATION

- .1 Excavate to lines, grades, elevations and dimensions as indicated on the drawings.
- .2 Do not disturb soil within designated tree protection areas.

- .1 Where permitted, roots or branches may be cut only by a qualified tree care professional, and in full compliance with the City Policy.
- .3 For trench excavation, unless otherwise authorized by Consultant or Owner in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave trench open at end of day's operation.
- .4 Keep excavated and stockpiled materials safe distance away from edge of trench.
- .5 Restrict vehicle operations directly adjacent to open trenches.
- .6 Dispose of surplus and unsuitable excavated legally off-site.
- .7 Do not obstruct flow of surface drainage or natural watercourses.
- .8 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
- .9 Remove unsuitable material from trench bottom including those that extend below required elevations to extent and depth as directed by Owner and Consultant.
- .10 Correct unauthorized over-excavation as follows:
 - .1 Fill under bearing surfaces and footings with concrete specified for footings.
 - .2 Fill under other areas with Granular 'B' Type II fill compacted to not less than 98% of corrected Standard Proctor maximum dry density.
- .11 Hand trim, make firm and remove loose material and debris from excavations.
 - .1 Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.
- .12 Install geotextiles, if required, in accordance with Section 31 32 19.16 - Geotextile soil stabilization.

3.9 FILL TYPES AND COMPACTION

- .1 Use types of fill as indicated or specified below.
 - .1 Within landscape areas, use of excavated soil materials or imported, clean soil materials is permitted for backfilling as indicated on the drawings, subject to Owner and Consultant Review.
 - .1 Do not use unsuitable materials as defined above.
 - .2 Within 2 metres of any area where backfill may support structures or pavements, use Granular 'B' Type II fill compacted to not less than 98% of corrected Standard Proctor maximum dry density.
 - .3 Place unshrinkable fill in areas as indicated.

3.10 BEDDING AND SURROUND OF UNDERGROUND SERVICES

- .1 Place and compact granular material for bedding and surround of underground services as indicated on drawings or as directed by the utility owner.
- .2 Place bedding and surround material in unfrozen condition.

3.11 BACKFILLING

- .1 Do not proceed with backfilling operations until completion of following as applicable:
 - .1 Completion of any third-party inspections or sampling.
 - .2 Review of completed work by Owner and Consultant.
 - .3 Inspection, testing, approval, and recording location of underground utilities.
 - .4 Removal of concrete formwork.
 - .5 Removal of shoring and bracing; backfilling of voids with satisfactory soil material.

- .2 Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.
- .3 Do not use backfill material which is frozen or contains ice, snow or debris.
- .4 Place backfill material in uniform layers not exceeding 150 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.
- .5 Backfilling around installations:
 - .1 Place bedding and surround material as specified elsewhere.
 - .2 Do not backfill around or over cast-in-place concrete within 24 hours after placing of concrete.
 - .3 Place layers simultaneously on both sides of installed Work to equalize loading.
 - .4 Where temporary unbalanced earth pressures are liable to develop on walls or other structures:
 - .1 Permit concrete to cure for minimum 14 days or until it has sufficient strength to withstand earth and compaction pressure or:
 - .2 Erect bracing or shoring to counteract unbalance and leave in place until earth pressures are balanced.
- .6 Place unshrinkable fill in areas as indicated.
 - .1 Consolidate and level unshrinkable fill with internal vibrators.
- .7 Install drainage system in backfill as indicated.

3.12 RESTORATION

- .1 Upon completion of Work, remove waste materials and debris in accordance with General and Supplementary Conditions and to Owner's satisfaction.
- .2 Replace topsoil as indicated.
- .3 Reinstate lawns to elevation which existed before excavation.
- .4 Reinstate pavements disturbed by excavation to thickness, structure and elevation which existed before excavation.
- .5 Clean and reinstate areas affected by Work as directed by Owner and Consultant.
- .6 Protect newly graded areas from traffic and erosion and maintain free of trash or debris.

END OF SECTION 31 23 33.01

PART - 1 GENERAL

1.1 SUMMARY

- .1 Specifies requirements for supplying and placing crushed gravel or quarried stone as a granular base to lines, grades and typical cross sections indicated.

1.2 RELATED REQUIREMENTS

- .1 Section 31 22 13 Rough Grading
- .2 Section 31 23 33.01 Excavating, Trenching and Backfilling
- .3 Section 31 32 19 Geosynthetics
- .4 Section 33 41 16 Subdrainage Piping

1.3 REFERENCE STANDARDS

- .1 Reference to the listed standards shall be considered to include related standards and documents or standards referenced within the listed documents.
- .2 City of Toronto Engineering and Technical Services (ECS) Standard Specifications (TS):
 - .1 TS 1010 Amendment to Aggregates – Base, Subbase, Select Subgrade, and Backfill Material
- .3 Ontario Provincial Standard Specifications (OPSS):
 - .1 OPSS MUNI 1001, Material Specification for Aggregates, General.
 - .2 OPSS MUNI 1004, Material Specification for Aggregates – Miscellaneous.
 - .3 OPSS MUNI 1010, Material Specification for Aggregates, Base, Subbase, Select Subgrade, and Backfill Material.
 - .4 OPSS MUNI 1359, Material Specification for Unshrinkable Backfill.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Quality Control: in accordance with Section 01 45 00 - Quality Control:
 - .1 Inform Owner and Consultant at least 4 weeks prior to beginning Work, of proposed source(s) of fill, aggregates and any other materials to be used for the work.
 - .1 Provide source documentation of materials to be supplied including standard testing showing compliance with relevant OPSS requirements. Testing to have been completed within 1 calendar year of date of submittal.
 - .2 Where documentation is not available for any reason, Contractor shall arrange and pay for testing to be carried out by the same third-party contracted by the Owner or Consultant for Quality Assurance.
 - .2 Other submittals may be required due to unexpected conditions or as a result of the Contractors chose work method (i.e. dewatering or heave prevention methods).

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with General and Supplementary Conditions and with manufacturer's written instructions
- .2 Storage and Handling Requirements:
 - .1 Store materials in off-ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

PART - 2 PRODUCTS

2.1 MATERIALS

- .1 General:
 - .1 Materials shall conform to OPSS and standards referenced therein.
- .2 Aggregates:
 - .1 All aggregates used for the work shall confirm to TS 1010 / OPSS 1010, except as noted.
 - .2 Where not specified, any reference to Granular 'B' shall be read as a reference to Granular 'B' Type II only.
 - .3 Re-claimed Concrete Material (RCM), re-claimed asphalt, and slag of any type SHALL NOT BE USED without express written authorization by the Owner or Consultant.
- .3 Other materials as may be required for a complete installation shall be selected by the Contractor and subject to review by Consultant and Owner.

PART - 3 EXECUTION

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until removal.
- .3 Remove erosion and sedimentation controls only when directed to do so by Owner or Consultant.
 - .1 Restore and stabilize areas disturbed during removal.

3.2 PROOF ROLLING

- .1 Where proof-rolling is indicated, use standard roller or alternate equipment accepted by Consultant.
 - .1 Contractor to arrange attendance by representative of designated testing and inspection company.
- .2 Proof roll at sub-grade level unless otherwise directed.
- .3 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
- .4 Where proof rolling reveals areas of defective subgrade:
 - .1 Remove subgrade material to depth and extent as directed by Consultant.
 - .2 Backfill excavated subgrade with material indicated by Consultant in maximum 150 mm lifts and compact to 98% maximum dry density.
- .5 Where proof rolling reveals defective base or sub-base, remove defective materials to depth and extent as directed by Consultant and replace with new materials in accordance with this section at no extra cost.

3.3 PLACEMENT AND INSTALLATION

- .1 Place granular base after sub-base or subgrade surface has been accepted by the Consultant.
- .2 Placing:
 - .1 Construct granular base to depth and grade in areas indicated.

- .2 Ensure no frozen material is placed.
- .3 Place material only on surface that is not saturated, is free of standing water and is capable of supporting construction equipment without rutting or deflecting.
- .4 Place material only on clean unfrozen surface, free from snow and ice.
- .5 Begin spreading base material on crown line or on high side of one-way slope.
- .6 Place material using methods which do not lead to segregation or degradation of aggregate.
- .7 For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.
- .8 Place material to full width in uniform layers not exceeding 150 mm compacted thickness.
- .9 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
- .10 Remove and replace that portion of layer in which material becomes segregated during spreading.
- .3 Compaction Equipment:
 - .1 Ensure compaction equipment is capable of obtaining required material densities.
- .4 Compacting:
 - .1 Compact to density not less than 100% maximum dry density.
 - .2 Shape and roll alternately to obtain smooth, even and uniformly compacted base.
 - .3 Apply water as necessary during compacting to obtain specified density.
 - .4 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers.
 - .5 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

3.4 TOLERANCES

- .1 Finished base surface to be within plus or minus 10 mm of established grade and cross section but not uniformly high or low.

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with General and Supplementary Conditions.
 - .1 Leave Work area clean at end of each day.
 - .2 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with General and Supplementary Conditions.

3.6 PROTECTION

- .1 Maintain finished base in condition conforming to this Section until succeeding material is applied.

END OF SECTION 32 11 23

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section includes requirements for structural surface preparation and installation of concrete pavers, bedding and joint material, edge restraints, cleaning and sealing compounds.

1.2 RELATED REQUIREMENTS

- .1 Section 31 23 33.01 Excavating, Trenching and Backfilling
- .2 Section 31 32 19 Geosynthetics
- .3 Section 32 11 23 Aggregate Base Courses

1.3 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates, latest version.
 - .2 ASTM C979/C979M, Standard Specification for Pigments for Integrally Colored Concrete, latest version.
- .2 CSA Group (CSA)
 - .1 CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete, latest version.
 - .2 CAN/CSA-A179, Mortar and Grout for Unit Masonry, latest version.
 - .3 CSA A231.1/A231.2, Precast Concrete Paving Slabs/Precast Concrete Pavers, latest version.
 - .4 CSA A283, Qualification Code for Concrete Testing Laboratories, latest version.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for precast concrete unit paving and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Not required.
- .4 Samples:
 - .1 Submit full size sample of each type and size of paver.
- .5 Test and Evaluation Reports:
 - .1 Submit following sampling and testing data:
 - .1 Sieve analysis for gradation of bedding and joint material.
 - .2 Unit paver sampling and testing.
 - .3 Evaluation of cleaning and sealing compounds.
 - .2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
 - .3 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.

1.5 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: company or person specializing in precast concrete paver installations with 5 years documented experience, approved by manufacturer.
- .2 Mock-ups:
 - .1 Not required.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with the General Conditions and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off-ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect precast concrete units from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART - 2 PRODUCTS

2.1 CONCRETE PAVERS

- .1 Concrete pavers: to CSA A23.1/A23.2 and as follows:
 - .1 Use "Series" paver by Unilock (special order).
 - .1 Sizes:
 - .1 100 mm x 100 mm x 70 mm height.
 - .2 Colour: 70% "Black Granite" and 30% "Mountain Mist" mixed randomly.
 - .3 Pattern: Staggered Bond aligned to adjacent concrete jointing patterns, with 3-row soldier course on all edges except where pavers abut a raised edge or wall. (Pattern may be adjusted where total width of paver area does not accommodate the desired pattern.) Note that one paver area located at the centre of the open space to the south of the new building will be installed according to a pattern to be provide by the Consultant, to resemble an image of a soccer ball.
 - .4 Finish: "Series" finish.
 - .2 Manufactured in moulds, with spacers, suitable for installation and delivered on site in cubes of laying panels, in protective wrapping.
 - .3 Pigment in concrete pavers: to ASTM C979/C979M.

2.2 BEDDING AND JOINTING MATERIAL

- .1 Bedding and joint sand: polymeric sand in a light grey colour.
- .2 Gradation: to CSA A23.1/A23.2, Table 4 - Grading Limits for Fine Aggregate, and CAN/CSA-A179 as follows:

Sieve Designation	% Passing for Bedding Sand	% Passing for Joint Sand
10 mm	[100]	
5 mm	[95-100]	[100]
2.5 mm	[80-100]	[95-100]

1.25 mm	[50-90]	[60-100]
630 microns	[25-65]	
600 microns		[35-80]
315 microns	[10-35]	
300 microns		[15-20]
160 microns	[2-10]	
150 microns		[2-15]

2.3 EDGE RESTRAINTS

- .1 Edge restraints shall be concrete, as detailed.
- .1 Refer to Section 03 30 00.09 Cast-In-Place Concrete – Short Form.

2.4 CLEANING COMPOUND

- .1 Clear, organic solvent, designed and recommended by manufacturer for cleaning concrete pavers of contamination encountered.
- .2 Acid based chemical detergent, designed and recommended by manufacturer for removal of contamination encountered on pavers.

2.5 SEALING COMPOUND

- .1 Do not use sealing compounds without written acceptance from Owner or Consultant.

PART - 3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate as exist or as previously installed under other Sections or Contracts are acceptable for rough grading installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written notice to proceed from Consultant and Owner.

3.2 STRUCTURAL SURFACE

- .1 Install aggregate base in accordance with Section 32 11 23 Aggregate Base Courses
- .2 Install concrete base in accordance with Section 03 30 00.09 Cast-In-Place Concrete – Short Form.
- .3 Verify that structural surfaces conform to levels and compaction required for installation of unit pavers. If discrepancies occur, notify Consultant.
- .4 Verify that top of structural surface (top of base) does not exceed plus or minus 10 mm of grade over 3 m straightedge.
- .5 Ensure that frozen or standing water are not present on the structural surface during installation.

3.3 STRUCTURAL CURBS

- .1 Verify that structural curbs conform to elevations and alignments required for installation of unit pavers. If discrepancies occur, notify Consultant.

3.4 PLACING OF BEDDING MATERIAL

- .1 Do not use joint sand for bedding sand.

- .2 Ensure bedding material is not saturated or frozen at all times until installation is complete.
- .3 Spread and screed material on structural surface to achieve indicated compacted thickness after vibrating pavers in place.
- .4 Do not disturb screeded material. Do not use bedding material to fill depressions in structural surface.

3.5 INSTALLATION OF CONCRETE PAVERS

- .1 Lay pavers to patterns indicated. Joints between pavers: 2 to 5 mm wide, or as recommended by manufacturer.
- .2 Use appropriate end, edge and corner stones. Saw cut pavers to fit around obstructions and at abutting structures.
- .3 Use a low amplitude, high frequency plate compactor capable of at least 22 kN centrifugal compaction force to vibrate pavers into bedding sand.
- .4 Inspect, remove, and replace chipped, broken and damaged pavers.
- .5 Sweep dry joint sand material into joints.
- .6 Settle sand by vibrating pavers with plate compactor.
- .7 Continue application of joint material and vibrating of pavers until joints are full. Do not vibrate within 1 m of unrestrained edges of pavers.
- .8 Complete installation to within 1 m of laying face, with sand-filled joints, at completion of each work day.
- .9 Sweep off excess joint material when installation is complete.
- .10 Final surface elevations not to exceed plus or minus 10 mm under 3 m long straightedge.
- .11 Surface elevation of pavers: 3 to 4 mm above adjacent drainage inlets, concrete collars or channels.
- .12 Ensure conformance of final elevations.

3.6 PRECAST CONCRETE UNIT CLEANING

- .1 Carry out cleaning at times and conditions recommended by manufacturer of cleaning compound.
- .2 Remove and dispose of loose, extraneous materials from surfaces to be cleaned.
- .3 Apply cleaning compounds appropriate for removal of various contaminants encountered in accordance with manufacturer's recommendations.
- .4 Final surface to be free of contamination.

3.7 SEALING

- .1 Do not seal.

3.8 FIELD QUALITY CONTROL

- .1 Testing of pavers to follow procedures outlined in Section 01 45 00 Quality Control.

3.9 CLEANING

- .1 Progress Cleaning: clean in accordance with General and Supplementary Conditions.
 - .1 Leave Work area clean at end of each day.
 - .2 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with General and Supplementary Conditions.

END OF SECTION 32 14 13

PART - 1 GENERAL

1.1 SUMMARY

- .1 This section includes materials and installation of chain link fences and gates.

1.2 RELATED REQUIREMENTS

- .1 Section 03 30 00.09 Cast-in-Place Concrete – Short Form
- .2 Section 05 50 00 Metal Fabrications

1.3 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A90/A90M, Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
 - .3 ASTM A121, Standard Specification for Zinc-Coated (Galvanized) Steel Barbed Wire.
 - .4 A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .5 ASTM C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
 - .6 ASTM F1664, Standard Specification for Poly(Vinyl Chloride) (PVC)-Coated Steel Tension Wire Used with Chain-Link Fence.
 - .7 ASTM A123/A123M, Standard Specification for Zinc (Hot Dip Galvanized) coatings on Iron and Steel Products.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-138.1, Fabric for Chain Link Fence.
 - .2 CAN/CGSB-138.2, Steel Framework for Chain Link Fence.
 - .3 CAN/CGSB-138.3, Installation of Chain Link Fence.
 - .4 CAN/CGSB-138.4, Gates for Chain Link Fence.
 - .5 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.
- .3 CSA Group (CSA)
 - .1 CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CAN/CSA-A3000, Cementitious Materials Compendium.
- .4 Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for concrete mixes, fences, posts and gates and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 If indicated, submit shop drawings indicating components, dimensions, sizes, assembly, anchorage and installation details for each furnishing specified.

PART - 2 PRODUCTS

2.1 MATERIALS

- .1 Concrete mixes and materials: in accordance with 03 30 00.09 Cast-in-Place Concrete – Short Form.
- .2 Concrete mixes and materials: in accordance with CSA A23.1.
 - .1 Compressive strength: 20 MPa minimum at 28 days.
- .3 Chain-link fence fabric: to CAN/CGSB-138.1.
 - .1 Galvanized (GAW) wire mesh, 38 mm X 38 mm wire spacing, 9 and 6 gauge as indicated.
 - .2 Height of fabric: as indicated.
- .4 Posts, braces and rails: to CAN/CGSB-138.2, galvanized steel pipe. Dimensions as indicated.
- .5 Tension wire (not used): to CAN/CGSB-138.2, single strand, galvanized steel wire.
- .6 Tension bar: to ASTM A653/A653M, 5 x 20 mm minimum galvanized steel.
- .7 Tie wire fasteners: aluminum or aluminum alloy wire, black vinyl coated.
- .8 Gates: to CAN/CGSB-138.4.
- .9 Gate frames: to ASTM A53/A53M, galvanized steel pipe, standard weight 45 mm outside diameter pipe for outside frame, 35 mm outside diameter pipe for interior bracing.
 - .1 Fabricate gates as indicated with electrically welded joints, and hot-dip galvanized after welding.
 - .2 Furnish gates with galvanized malleable iron hinges, latch and latch catch with provision for padlock which can be attached and operated from either side of installed gate.
 - .3 Furnish double gates with chain hook to hold gates open and/or centre rest with drop bolt for closed position, as indicated.
- .10 Fittings and hardware: to CAN/CGSB-138.2, cast aluminum alloy unless otherwise indicated.
 - .1 Tension bar bands: 3 x 20 mm minimum galvanized steel or 5 x 20 mm minimum aluminum.
 - .2 Post caps to provide waterproof fit, to fasten securely over posts and to carry top rail.
 - .3 Turnbuckles to be drop forged.
- .11 Organic zinc rich coating: to CAN/CGSB-1.181 or MPI #18.
- .12 Grounding rod: if required, follow electrical specifications. If not specified, use 16 mm diameter copperwell rod, 3 m long.

2.2 FINISHES

- .1 Galvanizing:
 - .1 For chain link fabric: to CAN/CGSB-138.1 Grade 2.
 - .2 For pipe: 550 g/m² minimum to ASTM A90.
 - .3 For barbed wire: to ASTM A121, Class 2 CAN/CGSB-138.2.
 - .4 For other fittings: to ASTM A123/A123M.

PART - 3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for chain link fence and gate installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written notice to proceed from Consultant and Owner.

3.2 ERECTION OF FENCE

- .1 Erect fence along lines as indicated and to CAN/CGSB-138.3.
- .2 Excavate post holes to dimensions indicated.
- .3 Space line posts equally, as indicated and measured parallel to ground surface.
- .4 Space straining posts at equal intervals not to exceed 150 m if distance between end or corner posts on straight continuous lengths of fence over reasonably smooth grade, is greater than 150 m.
- .5 Install additional straining posts at sharp changes in grade and where directed by Consultant.
- .6 Install corner post where change in alignment exceeds 10 degrees.
- .7 Install end posts at end of fence and at buildings.
- .8 Install gate posts on both sides of gate openings.
- .9 Place concrete in post holes then embed posts into concrete to depths indicated.
 - .1 In softscape areas: extend concrete 50 mm above ground level and slope to drain away from posts.
 - .2 In hardscape areas: terminate concrete 150 mm below indicated finished grade level and slope to drain away from posts.
 - .3 Brace to hold posts in plumb position and true to alignment and elevation until concrete has set.
- .10 Install rails, braces and fence fabric after concrete has cured, minimum of 5 days.
- .11 Install brace between end and gate posts and nearest line post, placed in centre of panel and parallel to ground surface or as indicated].
 - .1 Install braces on both sides of corner and straining posts in similar manner.
- .12 Install caps and/or overhang tops as indicated.
- .13 Install top rail between posts and fasten securely to posts and secure waterproof caps and overhang tops.
- .14 Install bottom and middle rails where and as indicated.
- .15 Lay out fence fabric. Stretch tightly to tension recommended by manufacturer and fasten to end, corner, gate and straining posts with tension bar secured to post with tension bar bands spaced at 300 mm intervals.
 - .1 Install fabric on side of fence as indicated.
- .16 Secure fabric to all posts, rails and/or tension wires with tie wires at 450 mm intervals.
 - .1 Give tie wires minimum two twists.

- .17 Install grounding rods if and as indicated.

3.3 INSTALLATION OF GATES

- .1 Deliver gates to site fully assembled.
- .2 Install gates in locations as indicated.
- .3 Level ground between gate posts and set gate bottom approximately 40 mm above ground surface.
 - .1 Ensure bottom of gate is clear of ground surface minimum 25 mm through entire angle of swing.
- .4 Determine position of centre gate rest for double gate.
 - .1 Cast gate rest in concrete as directed.
 - .2 Dome concrete above ground level to shed water.
- .5 Install gate stops if and where indicated.

3.4 TOUCH UP

- .1 Clean damaged surfaces or field welds with wire brush removing loose and cracked coatings. Apply two coats of organic zinc-rich paint to damaged areas and field welded areas.
 - .1 Pre-treat damaged surfaces according to manufacturers' instructions for zinc-rich paint.
 - .2 Prevent over-spray during touch-up. Clean overspray from any affected surfaces.
- .2 For vinyl-coated fences, provide matching touch-up per supplier's recommendations.

END OF SECTION 32 31 13

PART - 1 GENERAL

1.1 SUMMARY

- .1 Section includes site furnishings supply and installation requirements.

1.2 RELATED REQUIREMENTS

- .1 Section 01 41 00 Regulatory Requirements
- .2 Section 03 30 00.09 Cast-in-Place Concrete – Short Form
- .3 Section 31 23 33.01 Excavating, Trenching and Backfilling
- .4 Section 31 32 19 Geosynthetics
- .5 Section 32 11 23 Aggregate Base Courses

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's instructions, printed product literature and data sheets for furnishings and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit shop drawings indicating dimensions, sizes, assembly, anchorage and installation details for each furnishing specified.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for care and cleaning of site furnishings.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with the General Conditions and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in off-ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect furnishings from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART - 2 PRODUCTS

2.1 SUBSTITUTION REQUESTS

- .1 For products marked "or equal," submissions for approved equal will be reviewed after award and must be submitted within 10 business days of purchase order issuance. Submissions must include complete manufacturer documentation to allow for comparison with the specified product. In the event of rejection of submission, Contractor will be responsible to provide the specified product. The Owner will not accept any cost or delay due to rejection of submission.

2.2 DECORATIVE PARK BENCH

- .1 Use Maglin "Ogden" Bench.

- .1 Manufacturer: Maglin Site Furniture
- .2 Model: OGM1900, or equal.
 - .1 Length: 6-feet / 1.8 metres.
 - .2 Raised back: included.
 - .3 Side arms: included (one side).
 - .4 Centre arm: included.
 - .5 Surface mount.
- .3 Finishes:
 - .1 Metal castings and accessories:
 - .1 “STANDARD” finish shall be manufacturer’s standard “gunmetal” colour.
 - .2 “DECORATIVE” finish shall be a custom colour to be determined by Consultant in consultation with the supplier. The same custom colour shall be used throughout this Contract.
 - .2 Slats: thermally modified ash wood.

2.3 SEAT WALL TOPPER

- .1 Use Maglin “Ogden” customized bench toppers only, in the configurations noted below and indicated on the drawings.
 - .1 Manufacturer: Maglin Site Furniture
 - .2 Model: OGM 1900-196746, Straight Wall Mount Bench, Backless with Centre Armrest, or equal.
 - .1 Length: 1.82 m
 - .2 Raised back: not included.
 - .3 Side arms: not included.
 - .4 Centre arm: included.
 - .5 Surface mount.
 - .3 Model: OGM 1900-196748, Straight Wall Mount Bench , Backless with No Armrests, or equal.
 - .1 Length: 1.82 m
 - .2 Raised back: not included.
 - .3 Side arms: not included.
 - .4 Centre arm: not included.
 - .5 Surface mount.
 - .4 Model: OGM 1900-196749, Straight Wall Mount Bench with Back and Centre Armrest, or equal.
 - .1 Length: 1.82 m
 - .2 Raised back: included.
 - .3 Side arms: not included.
 - .4 Centre arm: included.
 - .5 Surface mount.
 - .5 Model: OGM 1900-196750, Straight Wall Mount Bench with Back and No Armrest, or equal.
 - .1 Length: 1.82 m
 - .2 Raised back: included.
 - .3 Side arms: not included.
 - .4 Centre arm: not included.

.5 Surface mount.

.6 Finishes:

.1 Metal castings and accessories: manufacturer's standard "gunmetal" colour.

.2 Slats: thermally modified ash wood.

2.4 BICYCLE RACK

.1 Use Maglin "300 Series" bicycle rack.

.1 Manufacturer: Maglin Site Furniture.

.2 Model: MBR-0350-00002, 5 loops, 4 bike configuration, or equal.

.1 Length: 48-1/4" / 1.2 metres.

.2 Surface mount.

.3 Finishes:

.1 Metal castings and accessories: manufacturer's standard "gunmetal" colour.

2.5 BOLLARDS

.1 Use Maglin "500 Series" bollards, or equal.

.1 Manufacturer: Maglin Site Furniture.

.2 Standard / Permanent

.1 Use model # MBO-0500-00001 (base type 1)

.3 Finishes:

.1 Use manufacturer's standard "gunmetal" colour.

2.6 SIGN POST (FOR WASTE AND RECYCLING BIN)

.1 Conform to OPSD 989.110 "Small Sign Support System SQR-LOC Perforated Steel Square Post System Installation – Single Post Assembly, or equal.

.1 Reference to detail incorporates references to related OPS standards.

.2 Solid Waste Services to provide waste bins, signage and fastenings/cablings.

.3 Finish:

.1 Galvanized.

2.7 DECORATIVE CLUSTER SEATING

.1 "4 SEAT" and "3 SEAT" MODELS:

.1 Manufacturer: Maglin Site Furniture.

.2 Model: "MTB-040-00024", or equal.

.1 Table height: 29.5" / 74.9 cm

.2 Total width: 62.25" / 158.1 cm

.3 Seat height: 17.5" / 44.5 cm.

.4 Surface mount.

.2 "3 SEAT" MODEL:

.1 Order 4-SEAT model. If delivered assembled, remove one seat and deliver to Owner. If delivered unassembled, deliver 4th seat directly to Owner, do not install.

.3 Finishes:

.1 Metal frame and accessories: use one of the following as indicated on plan:

.1 "STANDARD" finish shall be manufacturer's standard "gunmetal" colour.

- .2 "DECORATIVE" finish shall be a custom colour to be determined by Consultant in consultation with the supplier. The same custom colour shall be used throughout this Contract.

- .2 Slats: thermally modified ash wood.

2.8 CUSTOM ALUMINUM SHADE SHELTERS

- .1 Use pre-coordinated, pre-engineered custom shelters or equal.
 - .1 Manufacturer: sturdesign
 - .2 Model: 1462(2)-CP-IRR-CV "Custom Pergola"
 - .1 Completed Dimensions: as indicated on the drawings.
 - .2 Frame: 152mm x 152mm columns and 152mm x 152mm beams constructed with 'SturLock' internally concealed stainless-steel connection system and stainless-steel hardware. Mounting plates: 254mm x 254mm 4-bolt, with covers.
 - .3 Roof: inset 76mm x 76mm rafters with 3mm thick solid aluminum panels.
 - .4 All aluminum to ASTM B221.
 - .5 Electrical provision: none.
 - .3 Finishes:
 - .1 Standard Stur Design powder coat or stock RAL powder-coating, colour to be selected from manufacturer's standard colour chart.
- .2 Note: Owner will procure engineered structural drawings prior to Contract Award for use in permit submissions.

PART - 3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for exterior site furnishing installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written notice to proceed from Consultant and Owner.

3.2 PREPARATION

- .1 Locate and protect utility lines.
- .2 Notify and acquire written acknowledgement from utility authorities before beginning installation work

3.3 INSTALLATION

- .1 Assemble furnishings in accordance with manufacturer's written recommendations.
- .2 Install furnishings manufacturer's written instructions: true, plumb, and securely anchored.
 - .1 Use tamper-proof fasteners.
 - .2 Where threaded rods are used, they shall be supplied in appropriate lengths and inserted to such depths that cutting will not be required unless agreed in writing by the Owner and Consultant.
 - .1 If cutting is required, cut down to less than 2 threads.
 - .2 Rods cut by the Contractor or supplied with cut ends shall be painted with 2 coats of zinc-based primer. Minimize overspray.
- .3 Touch-up damaged finishes to satisfaction of Owner and Consultant.

3.4 CUSTOM ALUMINUM SHADE SHELTER COORDINATION/INSTALLATION

- .1 Refer to Section 01 41 00 Regulatory Requirements
- .2 Obtain stamped drawings and building permit application from supplier. Coordinate with Owner and Consultant to apply for permit.
- .3 Construct footings and walls to be used as footings in accordance with permit drawings.
 - .1 Coordinate with landscape plans.
 - .2 Obtain anchorage placement templates from supplier in advance and cast anchorage into footings and into walls to be used as footings.
- .4 Coordinate installation of shelter using supplier's preferred installer.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by site furnishings installation.

END OF SECTION 32 33 00

PART - 1 GENERAL

1.1 SUMMARY

- .1 This Section specifies requirements for constructing sub-drains with granular filter and/or geotextile filter material.

1.2 RELATED REQUIREMENTS

- .1 Section 31 23 33.01– Excavating, Trenching and Backfilling
- .2 Section 31 32 19.16 - Geotextile soil stabilization.
- .3 Section 32 18 20 Beach Volleyball Sand Surface
- .4 Section 32 18 23 Baseball and Softball Clay Surface
- .5 Section 32 91 19.14 Sport Field Root Zone Placement and Grading
- .6 City of Toronto Standard Detail T-708.020 Connection Detail for Pipe at Catch Basin or Maintenance Hole.

1.3 REFERENCE STANDARDS

- .1 Reference to the listed standards shall be considered to include related standards and documents or standards referenced within the listed documents.
- .2 Ontario Provincial Standard Specifications (OPSS):
 - .1 OPSS MUNI 405 Pipe Subdrains
 - .2 OPSS MUNI 1840 Non-Pressure Polyethylene Plastic Pipe Products
- .3 Sports Turf Association
 - .1 Athletic Field Construction Manual, Second Edition. (AFCM)

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for pipes, pipe fittings, tiles, and aggregate and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates:
 - .1 If requested by Consultant, submit manufacturer's certification that drain pipe materials meet requirements of this Section.
 - .2 Certification to be marked on pipe.
- .4 Test and Evaluation Reports:
 - .1 If requested by Consultant, submit manufacturer's test data that drain pipe materials meet requirements of this Section.
- .5 As-built Drawings
 - .1 Installed locations of sport field subdrainage pipes shall be recorded by survey or GPS and provided electronically with close-out submittals.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's recommendations.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations.
 - .2 Store and protect pipes and tiles from damage.
 - .3 Replace defective or damaged materials with new.

PART - 2 PRODUCTS

2.1 MATERIALS

- .1 All pipe and fittings: to OPSS 1840, size(s) and types as indicated.
 - .1 Pipes used for sports filed drainage shall be provided without geotextile cover or filter sock unless required due to high silt and fine sand content in the root zone material (over 50% combined).
 - .2 All pipe shall be new, produced within six months of delivery to site.
- .2 Bedding gravel and gravel filter material for general purpose installations shall be in accordance with Section 31 23 33.01– Excavating, Trenching and Backfilling and as indicated on the drawings.
- .3 Drainage stone for sport filed drainage shall be washed stone conforming to the requirements of the AFCM.
- .4 Aggregate for French drain: in accordance with Section 31 23 33.01– Excavating, Trenching and Backfilling and as indicated on the drawings.

PART - 3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate as exist or as previously installed under other Sections or Contracts are acceptable for rough grading installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written notice to proceed from Consultant and Owner
- .2 No work shall proceed when rutting may occur in rough-graded sport field areas.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until removal.
- .3 Remove erosion and sedimentation controls only when directed to do so by Owner or Consultant.
 - .1 Restore and stabilize areas disturbed during removal.

3.3 TRENCHING

- .1 Perform trenching and backfilling in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Place bedding or filter material after review of trench by Consultant.
- .3 For sport field sub-drainage:

- .1 Use only laser-guided trenching equipment capable of maintaining a maximum tolerance of +/- 10 mm over a distance of 3 metres. Trenching equipment shall be capable of removing excavated material from the work area.
- .2 Only flotation-tire-equipped equipment shall be used for trenching, laying pipe or laying drainage stone.

3.4 BEDDING

- .1 Place layer of bedding material as indicated and compact to minimum 95% of maximum density to ASTM D698.

3.5 INSTALLATION OF PIPE SUB-DRAINS

- .1 Carry out installation of bedding, pipe and trench immediately after trenching to minimize slumping of sub-grade materials into trench.
 - .1 Any subgrade materials in the trench shall be removed prior to any subsequent work.
- .2 Lay pipe drains on prepared bed, true to line and grade with inverts smooth and free of sags or high points.
 - .1 Ensure barrel of each pipe is in contact with bed throughout full length.
- .3 Begin laying at outlet and proceed in upstream direction.
- .4 Lay perforated pipes with perforations as indicated. If not indicated, place perforations downward.
- .5 Lay bell and spigot pipe with bell ends facing upstream.
 - .1 Do not mortar joints.
- .6 Cover joints of bell and spigot pipe with two-ply tar paper strips not less than 150 mm wide.
 - .1 Use strips of sufficient length to permit ends to be laid flat on bedding and turned outward on either side of pipe for a minimum distance of 75 mm.
- .7 Make joints tight in accordance with manufacturer's instructions.
- .8 Make watertight connections to existing drains, new or existing manholes and catch basins where indicated or as directed by Consultant.
- .9 Plug open upstream ends of pipes with watertight concrete, steel or wood bulkheads.
- .10 Surround pipe with bedding gravel and compact as indicated.
- .11 Surround and cover drain with filter material in uniform 150 mm layers to elevation as indicated and compact to at least 95% maximum density to ASTM D698.
- .12 Wrap or sleeve perforated pipe with geotextile filter as indicated.
- .13 Backfill remainder of trench to Section 31 23 33.01 - Excavating, Trenching and.
- .14 Do not place bedding, bedding surround and backfill materials in frozen condition.
- .15 Protect sub-drains against flotation during installation.
- .16 Install "Y" connections to surface as indicated, for flushing.

3.6 CONNECTIONS TO MUNICIPAL FACILITIES

- .1 Connect pipe sub-drains to municipal storm sewer system where indicated.
- .2 Connection to existing catch basins or maintenance holes shall be performed according to City of Toronto Standard Detail T-708.020 Connection Detail for Pipe at Catch Basin or Maintenance Hole.

3.7 INSTALLATION OF FRENCH DRAINS

- .1 Install French drains as indicated.
- .2 Backfill remainder of trench to Section 31 23 33.01 - Excavating, Trenching and Backfilling and as indicated.

3.8 TOLERANCES

- .1 Trenches shall be sloped smoothly, parallel to specified pipe slope. Slopes shall not deviate from indicated grades.
- .2 Bottom of trench to be generally smooth with localized deviations not to exceed 50 mm from required elevations.
- .3 Bedding layer to be generally smooth with localized deviations not to exceed 20 mm from required elevations.
- .4 Any areas found to be graded incorrectly or outside of tolerances shall be regraded promptly to Owner and Consultant's satisfaction.

END OF SECTION 33 41 16

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1 GENERAL

1.1 DESCRIPTION

- 1.1.1 The PV system shall consist of fixed axis roof mounted system with bi-facial panels connected in a net-metered configuration. The system shall operate in parallel with the electrical utility service and will be connected to the building distribution system.
- 1.1.2 The PV system shall be a 'turnkey' and will be provided by a single Solar EPC referred to herein as the PV Integrator to include all design, materials, labour, approvals and components as specified for a complete operational system for both roof PV system.
- 1.1.3 Roof mounted PV shall be designed as ballast type.
- 1.1.4 The PV Integrator must demonstrate a minimum of five (5) years' experience as a Solar EPC familiar with relevant renewable energy projects and must be prepared to satisfy the owner as to their competency for performing the work satisfactorily and within the time stated in the specifications and conditions provided.
- 1.1.5 The PV Integrator shall coordinate all work with the general contractor and all sub- trades.
- 1.1.6 The PV Integrator shall be responsible for obtaining all necessary electrical and building permits including inspections, regulatory authority provider approvals prior to construction.
- 1.1.7 Prepare and submit Connection Impact Assessment (CIA) applications to Toronto Hydro as per approved shop drawings and material selections. The local electric utility may have a requirement for further electrical studies, which may include or not be limited to power factor analysis, short circuit protection studies, grid wiring adequacy, or capacities of upstream equipment. If such requirements exist and are required by the serving electric utility, these requirements shall be fulfilled by the Contractor. Provide written documentation confirming the utility's approval of the interconnection of the solar energy electrical power generation system with the utility system.

1.2 RELATED WORK

- 1.2.1 Section 26 05 01 – Common Work Results – Electrical
- 1.2.2 Section 26 – Commissioning for Electrical Systems

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- 1.2.3 Section 26 – Identifications for Electrical Systems
- 1.2.4 Section 26 – Low Voltage Electrical Power Conductors and Cables
- 1.2.5 Section 26 – Moulded Case Circuit Breakers
- 1.2.6 Section 26 – Grounding – Secondary
- 1.2.7 Section 26 – Power Systems Studies
- 1.2.8 Section 26 – Surge Protective Devices
- 1.2.9 Section 26 – Raceway and boxes for electrical systems
- 1.2.10 Section 26 – Enclosed switches and circuit breakers
- 1.2.11 Section 26 - Dry Type Transformer
- 1.2.12 Section 48 – Solar Energy Power Generation
- 1.3 STANDARDS
- 1.3.1 Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- 1.3.2 Ontario Building Code 2012 with all amendments
- 1.3.3 Ontario Electrical Safety Code, 28th Edition - 2021.
- 1.3.4 C22.2 No. 107.1-01 General Use Power Supplies
- 1.3.5 CSA C22.3 No-9/08 Interconnection of Distributed Resources and Electricity Supply Systems
- 1.3.6 Distribution System Code (DSC) of Ontario Energy Board
- 1.3.7 CAN/CSA-C22.2 No.257 Interconnecting Inverter based Micro-distributed resources to distribution systems
- 1.3.8 UL 1741 Inverters, Converters and Controllers for use in generating facility
- 1.3.9 Hydro One Distributed Generation Technical Interconnection Requirements

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- 1.3.10 Hydro One Inverter Based Distributed Energy Resource Monitoring and Control Requirements
- 1.3.11 American Society for Testing and Materials (ASTM):
 - 1.3.11.1 E772-15: Standard Terminology of Solar Energy Conversion
 - 1.3.11.2 E1038-15: Standard Test Method for Determining Resistance of Photovoltaic Modules to Hail by Impact with Propelled Ice Balls
- 1.3.12 Institute of Electrical and Electronics Engineers (IEEE):
 - 1.3.12.1 100 CD-13: The Authoritative Dictionary of IEEE Standards Terms
 - 1.3.12.2 519-14: Recommended Practices and Requirements for Harmonic Control in Electric Power Systems
 - 1.3.12.3 1526-03: Recommended Practice for Testing the Performance of Stand-Alone Photovoltaic Systems
 - 1.3.12.4 1547-03: Standard for Interconnecting Distributed Resources with Electric Power Systems
- 1.3.13 National Electrical Manufacturer's Association (NEMA):
 - 1.3.13.1 250-14: Enclosures for Electrical Equipment (1,000 Volts Maximum)
- 1.3.14 National Fire Protection Association (NFPA):
 - 1.3.14.1 70-17: National Electrical Code (NEC)
- 1.3.15 Underwriters Laboratories (UL):
 - 1.3.15.1 6-07: Electrical Rigid Metal Conduit – Steel
 - 1.3.15.2 94-13: Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Ed 6
 - 1.3.15.3 797-07: Electrical Metallic Tubing – Steel
 - 1.3.15.4 969-17: Standard for Marking and Labeling Systems
 - 1.3.15.5 1242-14: Standard for Electrical Intermediate Metal Conduit – Steel
 - 1.3.15.6 1703-02: Standard for Flat-Plate Photovoltaic Modules and Panels

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1.3.15.7 1741-10: Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources

1.4 QUALITY ASSURANCE

1.4.1 Products and Services pertaining to this specification shall comply with Paragraph, qualifications, in Section 26 05 01 - Common Work Results.

1.4.2 Solar Energy Electrical Power Generation System installer(s) shall demonstrate that they have successfully installed at least four projects within the past five years that, in aggregate, equal or exceed the size of the proposed project.

1.4.3 References shall be provided for each of the referenced qualified projects.

1.4.4 Supports and racking for solar photovoltaic system designs shall be prepared under the seal of a licensed Professional Structural Engineer (PE). Where applicable, such as roof top installations, the engineer shall also provide adequate review and structural analysis of the existing structure that will be supporting the proposed solar photovoltaic system. Among the documents that shall be submitted by the engineer are environmental loading analyses (including wind, snow, hail, and where applicable, seismic) and the rack and substrate's ability to withstand these environmental forces.

1.4.5 For paralleling arrangement, the system shall have anti-islanding capability such that it is incapable of exporting power to the utility distribution system in the absence of utility power. Paralleling must be approved by serving electric utility. Provide written correspondence from the utility confirming its requirements.

1.4.6 Investigate any other local ordinances that may apply to installation of a solar energy electrical generating system in the proposed location. Bring any conflicts with the drawings and specifications to the attention of the Engineer.

1.4.7 Use new products currently under manufacture that have been applied in similar installations for a minimum of two years.

1.4.8 All component parts of each item of equipment or device shall bear the manufacturer's nameplate, giving the name of manufacturer, description, size, type, serial or model number, electrical

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characteristics, etc., in order to facilitate maintenance or replacement.

1.4.9 Warranties:

1.4.9.1 Solar photovoltaic modules and inverter: 10-year manufacturer's warranty against defects in materials and workmanship.

1.4.9.2 Power output: 25-year manufacturer's power output warranty, with the first 10 years at 90% minimum rated power output and the balance of the 25 years at 80% minimum rated power output.

1.4.9.3 Existing roof: Notify warrantor of existing roofing system on prior to beginning work and on completion of work, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect. Submit documentation at project closeout.

1.5 SUBMITTALS

1.5.1.1 Shop Drawings:

1.5.1.1.1 Submit sufficient information to demonstrate compliance with drawings and specifications.

1.5.1.1.2 Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, wiring and connection diagrams, accessories, and nameplate data.

1.5.1.1.3 Include required Canadian Electrical Code signage for PV System installation

1.5.1.1.4 Include shop drawings for foundations and other support structures for the car port PV system. Show complete assembly and installation instructions for PV module mounting rack. Show structural connection to roof, wall, ground or other attachment as appropriate.

1.5.1.1.5 System Design Information:

1.5.1.1.5.1 Design Calculations

1.5.1.1.5.2 Site Plan Drawings

1.5.1.1.5.3 Riser diagram and general notes

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- 1.5.1.1.5.4 Complete PV system components and interconnecting wiring diagrams
- 1.5.1.1.5.5 Installation and assembly details
- 1.5.1.1.5.6 Wind and seismic deign information
- 1.5.1.1.5.7 Submit calculated annual power output for each of the proposed solar photovoltaic systems.
- 1.5.1.2 Product Data:
 - 1.5.1.2.1 Include detailed information for components of the solar energy electrical generation system.
 - 1.5.1.2.1.1 Wiring.
 - 1.5.1.2.1.2 Inverter.
 - 1.5.1.2.1.3 Photovoltaic modules.
 - 1.5.1.2.1.4 Rack System.
 - 1.5.1.2.1.5 Instrumentation.
 - 1.5.1.2.1.6 Switchgear.
 - 1.5.1.2.1.7 DC and AC disconnects.
 - 1.5.1.2.1.8 Combiner boxes.
 - 1.5.1.2.1.9 Raceways
 - 1.5.1.2.1.10 Remote Monitoring & Control systems including appropriate interfacing with existing facility data collection systems.
 - 1.5.1.3 Manuals:
 - 1.5.1.3.1 Submit, simultaneously with the shop drawings, complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts.
 - 1.5.1.3.1.1 Safety precautions.
 - 1.5.1.3.1.2 Operator restart.
 - 1.5.1.3.1.3 Startup, shutdown, and post-shutdown procedures.

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- 1.5.1.3.1.4 Normal operations.
- 1.5.1.3.1.5 Emergency operations.
- 1.5.1.3.1.6 Environmental conditions.
- 1.5.1.3.1.7 Preventive maintenance plan and schedule.
- 1.5.1.3.1.8 Troubleshooting guides and diagnostic techniques.
- 1.5.1.3.1.9 Wiring and control diagrams.
- 1.5.1.3.1.10 Maintenance and repair procedures.
- 1.5.1.3.1.11 Removal and replacement instructions.
- 1.5.1.3.1.12 Spare parts and supply list.
- 1.5.1.3.1.13 Parts identification.
- 1.5.1.3.1.14 Testing equipment and special tool information.
- 1.5.1.3.1.15 Warranty information.
- 1.5.1.3.1.16 Testing and performance data.
- 1.5.1.3.1.17 Contractor information.
- 1.5.1.3.2 If changes have been made to the maintenance and operating manuals originally submitted, then submit updated maintenance and operating manuals two weeks prior to the final inspection.
- 1.5.1.4 Certifications: Two weeks prior to final inspection, submit the following.
 - 1.5.1.4.1 Certification by the manufacturers of all major items of the solar energy electric generation system that the system conforms to the requirements of the drawings and specifications, and that they have jointly coordinated and properly integrated their equipment and controls to provide a complete and functional installation.
 - 1.5.1.4.2 Certification by the Contractor that the solar energy electric generation system has been properly installed, adjusted, tested, commissioned, and warrantied. Contractor shall make all necessary field measurements and investigations to ensure that the equipment and assemblies meet contract requirements.

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1.5.1.5 Estimated Annual Power Output: Submit calculated annual power output for each of the proposed solar photovoltaic systems.

1.5.2 If equipment submitted differs in arrangement from that shown on the drawings, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract and acceptable to the Engineer.

1.5.3 Submittals and shop drawings for independent but related items shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group. Final review and approval will be made only by groups.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Provide materials to fabricate functioning photovoltaic system in accordance with CSA, ASTM, IEEE, NEMA, NFPA, and UL, as specified in this section, and as shown on the drawings.

2.1.2 All equipment and materials located outdoors shall be resistant to sunlight, temperature humidity and other weather conditions to which they are exposed.

2.1.3 All electrical equipment and products shall have appropriate voltage, current, and temperature ratings for the intended application. This includes the terminals of the products. Wiring, combiner boxes and terminals near PV modules shall be rated for 90 Deg C.

2.1.4 Installation shall consist of fixed axis roof mounted system with panels mounted on a flat plane racking system with access below for installation, inspection and maintenance. Provide all necessary accessories for a complete, secure, and operational roof mounted solar PV system.

2.1.5 Provide system equipment capable of operating under the location's maximum and minimum documented temperatures during summer and winter times.

2.2 SOLAR PHOTOVOLTAIC (PV) MODULES

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- 2.2.1 PV modules shall meet or exceed the requirements of IEC 61215, IEC 61730 and UL 1703.
- 2.2.2 PV modules shall be framed, flat plate, non-concentrating, and employ mono crystalline or poly crystalline technology.
- 2.2.3 The PV modules shall have the following certifications at the time of their delivery on site;
 - 2.2.3.1 Listed to all applicable CSA standards
 - 2.2.3.2 Bear a mark as part of its nameplate or covering part of its name place certifying it to applicable Canadian standards
- 2.2.4 Each PV modules shall have one or more bypass diodes installed into each PV module either between each cell or each string of cells.
- 2.2.5 PV modules shall have a minimum 20-year warranty.
- 2.2.6 Manufacturer's technical sheets shall list the PV module characteristics, including;
 - 2.2.6.1 Current-voltage (I-V) curves
 - 2.2.6.2 Short Circuit current (Isc)
 - 2.2.6.3 Open circuit voltage (Voc)
 - 2.2.6.4 Max power current (Imp)
 - 2.2.6.5 Max power voltage (Vmp)
 - 2.2.6.6 Temperature coefficients of module power, voltage and current
 - 2.2.6.7 Module efficiency
 - 2.2.6.8 Power tolerance
 - 2.2.6.9 Max series fuse rating
 - 2.2.6.10 Module Physical dimension & weight
- 2.2.7 Hail Protection: Compliant with testing procedure per ASTM E-1038.
- 2.2.8 Lightning Protection: Shall ground according to manufacturer instructions per UL 1703.

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- 2.2.8.1 Shall have a fire performance of minimum Class C in accordance with IEC 61730
- 2.2.9 PV modules shall be constructed in accordance with the IEC 61730 to ensure safety qualification.
- 2.2.10 Shall have verification of compliance certificate to IEC 61215, IEC 61730 and IEC 60068
- 2.3 AC-DC INVERTER
- 2.3.1 The inverter shall be a single unit, capable of remote monitoring, be fail safe, meet the requirements for a grid connected inverter and meet Alectra's interconnection requirements.
- 2.3.2 Shall be listed to all applicable CSA standards, UL 1741 and 1699B.
- 2.3.3 Shall comply with CAN/CSA-C22.2 No 107 and CAN/CSA-C22.2 No 62109.
- 2.3.4 Shall comply with IEEE 519 and IEEE 1547.
- 2.3.5 The inverter's DC side shall be compatible with the PV system array output and be capable of stable operation over the range of voltages, currents, power levels and temperatures for the size, type and location of the array that it is connected and employ MMPT technology.
- 2.3.6 The inverter's AC side shall have unity power factor, be capable of operating in parallel with other inverters and local authority distribution. It shall also employ built in mechanism to shut down on over voltage, under voltage, over frequency, under frequency and anti-islanding
- 2.3.7 The inverter's operator interface shall consist of multi-line LCD text display on front with visual indicator showing whether the system is on-line or not.
- 2.3.8 Shall include maximum power point tracking (MPPT) features.
- 2.3.9 Shall include anti-islanding protection.
- 2.3.10 Shall have a dc arc fault circuit interrupter monitoring and protection.
- 2.3.11 Shall have internal load rated ac and dc disconnects

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- 2.3.12 Shall have sun spec plc controls or equivalent for rapid shutdown
- 2.3.13 Shall have dc reverse polarity protection, ac short circuit protection and dc & ac surge protection
- 2.4 GROUNDING
- 2.4.1 All applicable components of the solar energy electrical power generating system must be grounded per latest OESC requirements.
- 2.4.2 DC Ground-Fault Protector:
 - 2.4.2.1 Shall be listed per UL 1703.
 - 2.4.2.2 Shall comply with requirements of the OESC.
- 2.5 PHOTOVOLTAIC ARRAY CIRCUIT COMBINER BOX
- 2.5.1 Shall be listed to UL 1741.
- 2.5.2 Shall include internal overcurrent protection devices with dead front.
- 2.5.3 Shall be contained in non-conductive NEMA Type 4X enclosure.
- 2.5.4 Up to 48 volts DC: Shall use UL-listed DC breakers that meet CEC requirements for overcurrent protection.
- 2.5.5 Up to 600 volts DC, paralleling system: Shall use fuses instead of breakers.
- 2.5.6 Where applicable, combiner box shall be a disconnecting combiner box.
- 2.6 SWITCH/DISCONNECTING MEANS
- 2.6.1 Refer to Section 26 28 23
- 2.7 WIRING
- 2.7.1 Refer Section 26 05 19
- 2.7.2 All insulated wire shall be copper conductor.
- 2.7.3 All outdoor wiring shall be UV resistant and listed for temperature rating of 90 Deg C in wet locations.

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2.8 CONDUITS & RACEWAYS

2.8.1.1 Refer Section 26 05 24

2.8.1.2 Shall use expansion joints on long conduit runs.

2.8.1.3 Shall not be installed on photovoltaic modules.

2.9 MONITORING SYSTEM

2.9.1 Solar Generation Monitoring System shall have the following features:

2.9.1.1 Cloud based computing service using smart grid technology

2.9.1.2 Analytic function to monitor the performance of the PV System

2.9.1.3 Client facing, publicly addressable website to view live system performance of the PV System

2.9.1.4 Minimum data storage for 3 months

2.9.1.5 Alarm notification capability via email

2.9.1.6 System shall be inclusive of a revenue grade meter, power supply, fusing blocks, shorting blocks, RS484/422 ports, data logger, CTs etc. in an enclosure rated for installed location.

2.9.1.7 Include for installing communication cable between monitoring equipment and Owner's internet router.

2.10 PV MODULE RACKING

2.10.1 Shall provide for each module to be individually removed for maintenance, repair, or replacement.

2.10.2 Refer to structural drawings detailing the primary structural supports for the PV modules frame/racks.

2.10.3 Shall ensure that the bonding of all modules is not broken if a module is removed.

2.10.4 Shall be appropriately designed for the array tilt angle, angle of attachment structure, space availability and wind and snow loading. Shall maintain the module warranties.

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2.10.5 Shall comply to Project's Structural Specification and all local codes.

2.11 INSTRUMENTATION

2.11.1 Meters: For grid-connected system, use net smart meter provided by the serving electric utility.

2.11.2 Sensors:

2.11.2.1 Temperature sensor shall be a component in the MPPT control system.

2.11.2.2 Install additional data acquisition sensors to measure irradiance, wind speed, and ambient and PV module temperatures. Any additional sensors shall require a conduit separate from the current conductor conduit.

2.11.3 Data logger/Monitoring System: Shall be a packaged system capable of string-level monitoring or in the case of micro-inverters, capable of monitoring and logging an individual module's information.

2.11.3.1 Provide CTs and PTs as required by the Hydro's Measurement & Control System.

2.12 LABEL & MARKINGS

2.12.1 Warning signs and labels shall be supplied and installed in accordance with the latest Alectra standards and CEC requirements.

2.13 HYDRO ONE REMOTE MONITORING & CONTROL

2.13.1 Coordinate and install all necessary devices to comply with Hydro's remote monitoring and control requirements.

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Install the solar photovoltaic system in accordance with the OESC, this section, and the printed instructions of the manufacturer.

3.1.2 Prior to system start-up, ensure no copper wire remains exposed with the exception of grounding wire as allowed in certain circumstances per manufacturer's instructions.

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3.1.3 Wiring Installation:

3.1.3.1 Workers shall be made aware that photovoltaic modules will be live and generating electricity when there is any ambient light source and shall take appropriate precautions.

3.1.3.2 Utilize on-site measurements in conjunction with engineering designs to accurately cut wires and layout before making permanent connections.

3.1.3.3 Locate wires out of the way of windows, doors, openings, and other hazards. Ensure wires are free of snags and sharp edges that have the potential to compromise the wire insulation. All cabling shall be mechanically fastened. All cabling from the PV modules shall be installed in metallic conduits with suitable labelling.

3.1.3.4 Ensure breakers in combiner box are in the off position (or fuses removed) during combiner box wiring.

3.1.3.5 All wiring within enclosures shall be neatly bundled and anchored to permit easy access to devices and terminals.

3.1.3.6 All terminations need to use CSA listed box terminal or compression type connections.

3.1.4 Instrumentation: Install instruments as recommended by the manufacturer. Locate control panels inside a room accessible only to qualified persons.

3.1.5 Rack-Mounted Photovoltaic Installations:

3.1.5.1 Rack-mounted photovoltaic modules shall be installed in accordance with the manufacturer's installation instructions.

3.1.5.2 Systems shall be adequately anchored and braced per details on structural contract documents as well as capable of handling the array size.

3.1.5.3 Use module bypass diodes to counteract severe instances of shading, if required.

3.1.6 Provide safety signage per OESC.

3.1.7 Remove, replace, patch, and repair existing roofing materials and surfaces cut or damaged during installation of the solar energy electrical power generation system, by methods and with materials

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so as not to void existing roofing system warranty. Notify roof warrantor before proceeding.

- 3.1.8 Grounding: Grounding shall be carried out in accordance with applicable codes.
- 3.1.9 Labelling: Contractor shall coordinate and ensure that upto-date standards and requirements for warning signs and labels as per Alectra are installed.
 - 3.1.9.1 All equipment labels and warning signs shall be permanent, self-adhesive engraved phenolic (lamacoid-type) legend plates
- 3.1.10 Any building envelope penetration shall be sealed to prevent moisture movement into the envelope from the exterior or the interior using industry approved sealing methods according approved standard building practices.
- 3.2 FIELD QUALITY CONTROL
 - 3.2.1 Field Inspection: Perform in accordance with manufacturer's recommendations. Prior to initial operation, inspect the solar energy electrical power generation system for conformance to drawings, specifications, and OESC. In addition, include the following:
 - 3.2.1.1 Visual Inspection and Tests:
 - 3.2.1.1.1 Compare equipment nameplate data with specifications and approved shop drawings.
 - 3.2.1.1.2 Inspect physical, electrical, and mechanical condition.
 - 3.2.1.1.3 Verify required area clearances.
 - 3.2.1.1.4 Verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey after energization.
 - 3.2.1.1.5 Verify the correct operation of all sensing devices, alarms, and indicating devices.
 - 3.2.1.1.6 Verify that all cable entries from top of junction boxes are sealed per junction box rating.
 - 3.2.1.1.7 Verify all connections and integrity of printed circuit boards in all applicable junction boxes.

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- 3.2.2 Tests: Provide equipment and apparatus required for performing tests. Correct defects disclosed by the tests and repeat tests. Conduct tests in the presence of the Engineer.
- 3.2.3 Field test the PV array to verify electrical integrity and specified performance.
- 3.2.3.1 Module String Voltage Test: Prior to connecting wiring to the combiner box, use a digital multi-meter to ensure each series string's polarity is correct.
- 3.2.3.2 Operational Tests: Perform tests in accordance with the manufacturer's written recommendations.
- 3.2.3.3 All installations shall be inspected by both the Electrical Safety Authority and Hydro One.
- 3.3 FOLLOW-UP VERIFICATION
- 3.3.1 Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the solar photovoltaic electrical power generation system is in good operating condition and properly performing the intended function.
- 3.4 COMMISSIONING
- 3.4.1 For the net metering arrangement, the Contractor shall coordinate with Hydro One to establish an interconnection agreement.
- 3.4.2 Connect the solar photovoltaic electrical power generation system to the local electric utility grid only after receiving prior approval from the utility company.
- 3.4.3 Notify Hydro One no later than 15 working days prior to any commissioning tests to enable Alectra to witness the commissioning tests.
- 3.4.4 Confirm that the disconnect switch is available to Hydro operation.
- 3.4.5 Confirm communication established for metering.
- 3.4.6 Confirm monitoring and control as per Hydro.
- 3.4.7 Perform test to confirm operation of exterior disconnect switch in presence of Hydro personnel.
- 3.4.8 Commissioning Verification Report shall include as a minimum;

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Section Name: **Solar Energy Electrical Power Generation**
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- 3.4.8.1 Confirmation of installation and configuration
- 3.4.8.2 Single line diagram identifying as built Connection Point
- 3.4.8.3 Confirmation of posted warning signs on doors and switchgear
- 3.4.8.4 Confirmation that equipment and installations meet CSA and other applicable electrical safety standards
- 3.4.8.5 Protective device co-ordination.
- 3.4.8.6 Inverter trip settings as per CSA 107.1 with grid interactive mode and anti-islanding protection
- 3.4.8.7 PV string tests
- 3.4.9 Only qualified personnel shall connect the solar photovoltaic electrical power generation system to the serving electric utility grid.
- 3.5 INSTRUCTION
- 3.5.1 A complete set of operating instructions for the solar photovoltaic electrical power generation system shall be laminated or mounted under acrylic glass and installed in a frame near the equipment.
- 3.5.2 Furnish the services of a factory-trained technician for one, 4-hour training period for instructing personnel in the maintenance and operation of the solar photovoltaic electrical power generation system, on the date requested by the Engineer.

END OF SECTION

Project Name: FIFA - EAST VSTS CENTENNIAL PARK
Project No.: 2024-0112
Section Name: **Appendix A - Panel Schedules**
Section No.:
Date: August 30, 2024

APPENDIX A

PANEL SCHEDULES



PROJECT NAME: **FIFA East VSTS**
PROJECT NUMBER: **2024-0112**
DATE: July 26, 2024
ENGINEER/DESIGNER Stephen Nicholls

PANEL: **LP-2L01**
PAGE: 1 of 1
LOCATION: GROUND FLOOR

Panel Mains:		225 A	SC Rating:		As per Spec		Voltage:		120 / 208		Ph/Wire:		3ϕ /4W		Fed from:		REFER TO SLD	
BRKR	*	DESCRIPTION				C [W]	cct	PHASE			cct	C [W]	DESCRIPTION				*	BRKR
								A	B	C								
15A-1P	S	MEETING RM, UNIV WC, TEAM SANITARY (RM 07, 09, 16, 17)				856	1	●			2		SPACE				S	
15A-1P	S	DRESSING ROOM 15				724	3		●		4		SPACE				S	
15A-1P	S	SPARE					5			●	6		SPACE				S	
15A-1P	S	SPARE					7	●			8		SPACE				S	
15A-1P	S	MASSAGE ROOM/CORRIDOR LIGHTING (RM 3, 12, 13)				810	9		●		10		SPACE				S	
15A-1P	S	WASHROOM 14 LIGHTING				598	11			●	12		SPACE				S	
15A-1P	S	WARM-UP LOUNGE & EXTERIOR LIGHTING (RM 1)				943	13	●			14		SPACE				S	
15A-1P	S	CAFÉ & CUSTODIAL SERVICE LIGHTING (RM 04, 05)				357	15		●		16		SPACE				S	
15A-1P	S	CORRIDOR A & STORAGE & WC LIGHTING (RM 02, 10, 11, 22)				726	17			●	18		SPACE				S	
15A-1P	S	MECH./ ELEC./ IT ROOMS & OFFICES LIGHTING				793	19	●			20		SPACE				S	
15A-1P	S	WARM-UP LOUNGE STRIP LIGHTING (RM 01)				930	21		●		22		SPACE				S	
15A-1P	S	SPARE					23			●	24		SPACE				S	
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PROJECT NAME: FIFA East VSTS
PROJECT NUMBER: 2024-0112
DATE: July 26, 2024
ENGINEER/DESIGNER Yassine Benjelloun

PANEL: PP-2B01
PAGE: 1 of 2
LOCATION: GROUND FLOOR

Panel Mains:		225 A	SC Rating:	As per Spec	Voltage:	120 / 208		Ph/Wire:	3ϕ /4W	Fed from:	REFER TO SLD		
BRKR	*	DESCRIPTION	C [W]	cct	PHASE			cct	C [W]	DESCRIPTION	*	BRKR	
					A	B	C						
15A-1P	S	WARM-UP/ LOUNGE DOOR OPENERS (RM 1)	1000	1	●			2	1000	W/C C HAND DRYER (RM 11)	S	15A-1P	
15A-1P	S	NORTHWEST RECEPTACLES (RM 1, 6, 18-20)	800	3		●		4	1000	PLAYER'S RECOVERY RM DOOR OPENERS (RM 12)	S	15A-1P	
15A-1P	S	CORRIDOR A RECEPTACLES (RM 2)	800	5			●	6	1000	PLAYER'S RECOVERY RM & MASSAGE RM RECEPTACLES (RM 12-13)	S	15A-1P	
15A-1P	S	CORRIDOR B RECEPTACLES (RM 3)	1200	7	●			8	1000	PLAYER'S MASSAGE ROOM DOOR OPENERS (RM 13)	S	15A-1P	
15A-1P	S	CAFÉ REFRIGERATOR (RM 4)	1000	9		●		10	1000	W/C HAND DRYER (RM 14)	S	20A-1P	
15A-1P	S	CAFÉ REFRIGERATOR (RM 4)	1000	11			●	12	1000	W/C RECEPTACLES (RM 14)	S	20A-1P	
20A-1P	S	CAFÉ DISHWASHER (RM 4)	1800	13	●			14	1000	W/C HAND DRYER (RM 14)	S	15A-1P	
20A-1P	S	CAFÉ ABOVE COUNTER RECEPTACLE (RM 4)	1800	15		●		16	1000	W/C DOOR OPENERS (RM 14)	S	20A-1P	
20A-1P	S	CAFÉ ABOVE COUNTER RECEPTACLE (RM 4)	1800	17			●	18	1000	TEAM DRESSING RM DOOR OPENERS (RM 15)	S	20A-1P	
15A-1P	S	CUSTODIAL SERVICE POWER & DOOR OPENER (RM 5)	1000	19	●			20	600	TEAM DRESSING RM RECEPTACLES (RM 15)	S	20A-1P	
15A-1P	S	WORKFORCE OFFICE RECEPTACLES (RM 6)	900	21		●		22	1000	TEAM SANITARY FACILITIES DOOR OPENERS (RM 16)	S	20A-1P	
15A-1P	S	WORKFORCE OFFICE RECEPTACLES (RM 6)	900	23			●	24	1000	TEAM SANITARY FACILITIES HAND DRYER (RM 16)	S	15A-1P	
15A-1P	S	WORKFORCE OFFICE & MEETING RM D.O. (RM 6-7)	1000	25	●			26	1000	TEAM SANITARY FACILITIES RECEPTACLES (RM 16-17)	S	20A-1P	
20A-1P	S	MEETING RM RECEPTACLES (RM 7)	1500	27		●		28	1000	TEAM SANITARY FACILITIES DOOR OPENERS (RM 17)	S	15A-1P	
15A-1P	S	TEAM COACHES RM & W/C D D.O. (RM 8, 11)	1000	29			●	30	1000	TEAM SANITARY FACILITIES HAND DRYER (RM 17)	S	15A-1P	
15A-1P	S	COACHES RM RECEPTACLES (RM 8)	800	31	●			32	1800	IT ROOM CABLE TRAY RECEPTACLE (RM 19)	S	20A-1P	
15A-1P	S	UNIV. W/C DOOR OPENERS (RM 9)	1000	33		●		34	1800	IT ROOM CABLE TRAY RECEPTACLE (RM 19)	S	20A-1P	
20A-1P	S	UNIV. W/C RECEPTACLES (RM 9)	1000	35			●	36	1800	IT ROOM SECURITY CABINET RECEPTACLE (RM 19)	S	20A-1P	
15A-1P	S	UNIV. W/C HAND DRYER (RM 9)	1000	37	●			38	500	MECH RM BLDG AUTOMATION SYSTEM RECEPTACLE (RM 21)	S	15A-1P	
15A-1P	S	W/C D HAND DRYER (RM 10)	1000	39		●		40	1000	MECH RM & STORAGE RECEPTACLES (RM 21-22)	S	15A-1P	
20A-1P	S	W/C C & D RECEPTACLES (RM 10-11)	1000	39			●	42	500	RTU UPS	S	15A-1P	

LEGEND: S : Standard Breaker
G : Ground Fault Circuit Interrupt
3G : 30mA Ground Fault Circuit Interrupt
A : Arc Fault Circuit Interrupt
(L) : Lock-on Device

OPTIONS: ☒ Main Breaker 0 A CSA Enclosure Rating: Type 1
☐ Feed-through/Double Lugs Tub Type: Single
☐ Isolated Ground Bus Mounting: Surface
☐ Integral SPD Total Circuits: 84

Demand "A" 10530 W
Demand "B" 12770 W
Demand "C" 10903 W

TOTAL DEMAND AMPS 105.6 A
TOTAL CONNECTED LOAD 52.4 kW
TOTAL DEMAND LOAD 34.2 kW

NOTES:



PROJECT NAME: **FIFA East VSTS**
PROJECT NUMBER: **2024-0112**
DATE: July 26, 2024
ENGINEER/DESIGNER Yassine Benjelloun

PANEL: **PP-2B01**
PAGE: 2 of 2
LOCATION: GROUND FLOOR

Panel Mains:		225 A	SC Rating:	As per Spec	Voltage:	120 / 208		Ph/Wire:	3ϕ /4W	Fed from:	REFER TO SLD				
BRKR	*	DESCRIPTION			C [W]	cct	PHASE A B C			cct	C [W]	DESCRIPTION		*	BRKR
15A-1P	S	SPARE				43	●			44	200	HEAT TRACING			15A-1P
15A-1P	S	SPARE				45		●		46	1800	ROOF RECEPTACLE			20A-1P
15A-1P	S	SPARE				47			●	48	576	BATTERY UNITS (RM 1, 15, 19, 20)			15A-1P
15A-1P	S	SPARE				49	●			50		SPARE			15A-1P
15A-1P	S	SPARE				51		●		52	1000	W/C HAND DRYER (RM 14)			15A-1P
15A-1P	S	SPARE				53			●	54	1000	W/C HAND DRYER (RM 14)			15A-1P
15A-1P	S	SPARE				55	●			56	1000	W/C HAND DRYER (RM 16)			15A-1P
15A-1P	S	SPARE				57		●		58	1000	W/C HAND DRYER (RM 17)			15A-1P
15A-1P	S	SPARE				59			●	60					15A-1P
15A-1P	S	SPARE				61	●			62					15A-1P
15A-1P	S	SPARE				63		●		64					15A-1P
15A-1P	S	SPARE				65			●	66					15A-1P
15A-1P	S	SPARE				67	●			68					15A-1P
15A-1P	S	SPARE				69		●		70					15A-1P
15A-1P	S	SPARE				71			●	72					15A-1P
15A-1P	S	SPARE				73	●			74					15A-1P
15A-1P	S	SPARE				75		●		76					15A-1P
15A-1P	S	SPARE				77			●	78					15A-1P
15A-1P	S	SPARE				79	●			80					15A-1P
15A-1P	S	CORRIDOR A DOOR OPENER (RM 2)			500	81		●		82					15A-1P
15A-1P						83			●	84					15A-1P

LEGEND:
S : Standard Breaker
G : Ground Fault Circuit Interrupt
3G : 30mA Ground Fault Circuit Interrupt
A : Arc Fault Circuit Interrupt
(L) : Lock-on Device

OPTIONS:
☒ Main Breaker: **hidi**
☐ Feed-through/Double Lugs
☐ Isolated Ground Bus
☐ Integral SPD
CSA Enclosure Rating: Type 1
Tub Type: Single
Mounting: Surface
Total Circuits: 84

Demand "A" 10530 W
Demand "B" 12770 W
Demand "C" 10903 W

TOTAL DEMAND AMPS 105.6 A
TOTAL CONNECTED LOAD 52.4 kW
TOTAL DEMAND LOAD 34.2 kW

NOTES:



PROJECT NAME: FIFA East VSTS
PROJECT NUMBER: 2024-0112
DATE: August 29, 2024
ENGINEER/DESIGNER Neil Pasco

PANEL: PP-2D01
PAGE: 1 of 2
LOCATION: INTERVIEW RM 24

Panel Mains:		225 A	SC Rating:	As per Spec	Voltage:	120 / 208		Ph/Wire:	3ϕ /4W	Fed from:	REFER TO SLD					
BRKR	*	DESCRIPTION			C [W]	cct	PHASE			cct	C [W]	DESCRIPTION			*	BRKR
						A	B	C								
15A-1P	S	INTERVIEW/FLASH POSITION ROOM AND HALL (RM 23-25)			771	1	●			2	1200	INTERVIEW RM & FLASH POSITION RM RECEPTACLES (RM 24-25)			S	15A-1P
15A-1P	S	PUBLIC WASHROOM LIGHTING (RM 26-37)			611	3		●		4	1000	UNIVERSAL W/C & W/C DOOR OPENERS (RM 26-27)			S	15A-1P
15A-1P	S	EXIT SIGNS FOR BU-5			18	5			●	6	1200	UNIVERSAL W/C RECEPTACLES (RM 26)			S	20A-1P
20A-2P	S	AIR CURTAIN AC-1			1258	7	●			8	500	UNIVERSAL WASHROOM ADULT CHANGING TABLE			S	15A-1P
	S				1258	9		●		10	1000	UNIVERSAL W/C HAND DRYER (RM 26)			S	15A-1P
20A-2P	S	AIR CURTAIN AC-1			1258	11			●	12	800	W/C RECEPTACLES (RM 27)			S	15A-1P
	S				1258	13	●			14	1000	W/C HAND DRYER (RM 27)			S	15A-1P
15A-1P	S	FFH-1 HALL (23)			1176	15		●		16	1000	W/C HAND DRYER (RM 28)			S	15A-1P
15A-1P	S	FFH-1 HALL (23)			1176	17			●	18	1000	W/C HAND DRYER (RM 29)			S	15A-1P
15A-1P	S	FFH-1 HALL (WASHROOM CORRIDOR)			1176	19	●			20	1000	W/C HAND DRYER (RM 30)			S	15A-1P
15A-1P	S	FFH-1 HALL (WASHROOM CORRIDOR)			1176	21		●		22	1000	W/C HAND DRYER (RM 31)			S	15A-1P
15A-2P	S	HHP-17 FLASH POSITION			530	23			●	24	1000	W/C HAND DRYER (RM 32)			S	15A-1P
	S				530	25	●			26	1000	W/C HAND DRYER (RM 33)			S	15A-1P
15A-2P	S	HHP-16 INTERVIEW ROOM			530	27		●		28	1000	W/C HAND DRYER (RM 34)			S	15A-1P
	S				530	29			●	30	1000	W/C HAND DRYER (RM 35)			S	15A-1P
50A-2P	S	HHP-15 HALL			2683	31	●			32	1000	W/C HAND DRYER (RM 36)			S	15A-1P
	S				2683	33		●		34	1000	W/C HAND DRYER (RM 37)			S	15A-1P
25A-2P	S	HHP-14 COORIDOR			1352	35			●	36	1000	SOUTH WASHROOMS DOOR OPENERS			S	15A-1P
	S				1352	37	●			38	500	FLASH POSITION DOOR OPENER (RM 25)			S	15A-1P
15A-1P	S	HALL & INTERVIEW RM DOOR OPENERS (RM 23, 24)			1000	39		●		40	144	BATTERY UNIT (RM 29)			S	15A-1P
15A-1P	S	CORRIDOR B & HAL DOOR OPENERS (RM 3, 23)			1000	41			●	42	1000	HALL RECEPTACLES (RM 23)			S	15A-1P

LEGEND: S : Standard Breaker
G : Ground Fault Circuit Interrupt
3G : 30mA Ground Fault Circuit Interrupt
A : Arc Fault Circuit Interrupt
(L) : Lock-on Device

OPTIONS: ☒ Main Breaker 0 A CSA Enclosure Rating: Type 1
☐ Feed-through/Double Lugs Tub Type: Single
☐ Isolated Ground Bus Mounting: Flush
☐ Integral SPD Total Circuits: 84

Demand "A" 10316 W
Demand "B" 9255 W
Demand "C" 8229 W

TOTAL DEMAND AMPS 85.8 A
TOTAL CONNECTED LOAD 47.4 kW
TOTAL DEMAND LOAD 27.8 kW

NOTES:



PROJECT NAME: **FIFA East VSTS**
PROJECT NUMBER: **2024-0112**
DATE: August 29, 2024
ENGINEER/DESIGNER Neil Pasco

PANEL: **PP-2D01**
PAGE: 2 of 2
LOCATION: INTERVIEW RM 24

Panel Mains:		225 A	SC Rating:		As per Spec		Voltage:		120 / 208		Ph/Wire:		3ϕ /4W		Fed from:		REFER TO SLD			
BRKR	*	DESCRIPTION					C [W]	cct	PHASE			cct	C [W]	DESCRIPTION					*	BRKR
									A	B	C									
20A-1P	S	OVERHEAD DOORS HALL					1176	43	●			44								
20A-1P	S	OVERHEAD DOORS HALL					1176	45		●		46								
20A-1P	S	OVERHEAD DOORS W/C					1176	47			●	48								
20A-1P	S	OVERHEAD DOORS W/C					1176	49	●			50								
								51		●		52								
								53			●	54								
								55	●			56								
								57		●		58								
								59			●	60								
								61	●			62								
								63		●		64								
								65			●	66								
								67	●			68								
								69		●		70								
								71			●	72								
								73	●			74								
								75		●		76								
								77			●	78								
								79	●			80								
								81		●		82								
								83			●	84								

LEGEND: S : Standard Breaker
G : Ground Fault Circuit Interrupt
3G : 30mA Ground Fault Circuit Interrupt
A : Arc Fault Circuit Interrupt
(L) : Lock-on Device

OPTIONS: ☒ Main Breaker: **hidi** CSA Enclosure Rating: Type 1
☐ Feed-through/Double Lugs Tub Type: Single
☐ Isolated Ground Bus Mounting: Flush
☐ Integral SPD Total Circuits: 84

Demand "A" 10316 W
Demand "B" 9255 W
Demand "C" 8229 W

TOTAL DEMAND AMPS 85.8 A
TOTAL CONNECTED LOAD 47.4 kW
TOTAL DEMAND LOAD 27.8 kW

NOTES:



PROJECT NAME: **FIFA East VSTS**
PROJECT NUMBER: **2024-0112**
DATE: August 29, 2024
ENGINEER/DESIGNER Neil Pasco

PANEL: **PP-2C01**
PAGE: 1 of 2
LOCATION: IT ROOM 19

Panel Mains:		100 A	SC Rating:	As per Spec	Voltage:	120 / 208			Ph/Wire:	3ϕ /4W	Fed from:	REFER TO SLD				
BRKR	*	DESCRIPTION			C [W]	cct	PHASE			cct	C [W]	DESCRIPTION			*	BRKR
							A	B	C							
15A-1P	S	SPARE				1	●			2						
15A-1P	S	SPARE				3		●		4						
15A-1P	S	SPARE				5			●	6						
30A-2P	S	SPARE				7	●			8						
	S					9		●		10						
30A-2P	S	SPARE				11			●	12						
	S					13	●			14						
30A-2P	S	SPARE				15		●		16						
	S					17			●	18						
						19	●			20						
						21		●		22						
						23			●	24						
						25	●			26						
						27		●		28						
						29			●	30						
						31	●			32						
						33		●		34						
						35			●	36						
						37	●			38						
						39		●		40						
						41			●	42						

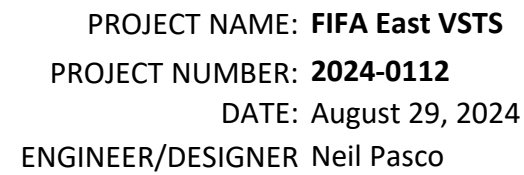
LEGEND: S : Standard Breaker
G : Ground Fault Circuit Interrupt
3G : 30mA Ground Fault Circuit Interrupt
A : Arc Fault Circuit Interrupt
(L) : Lock-on Device

OPTIONS: ☒ Main Breaker **0 A** CSA Enclosure Rating: Type 1
☐ Feed-through/Double Lugs Tub Type: Single
☐ Isolated Ground Bus Mounting: Surface
☐ Integral SPD Total Circuits: 60

Demand "A" **0 W**
Demand "B" **0 W**
Demand "C" **0 W**

TOTAL DEMAND AMPS **0.0 A**
TOTAL CONNECTED LOAD **0.0 kW**
TOTAL DEMAND LOAD **0.0 kW**

NOTES:



PAGE: 2 of 2
LOCATION: IT ROOM 19

LEGEND:	S	: Standard Breaker
	G	: Ground Fault Circuit Interrupt
	3G	: 30mA Ground Fault Circuit Interrupt
	A	: Arc Fault Circuit Interrupt
	(L)	: Lock-on Device

Demand "A"	0 W
Demand "B"	0 W
Demand "C"	0 W
TOTAL DEMAND AMPS 0.0 A	
TOTAL CONNECTED LOAD 0.0 kW	
TOTAL DEMAND LOAD 0.0 kW	

PP-2C01.xlsm

appendix B

STANDARD

CITY OF TORONTO

SPECIFICATIONS

- TS 5.00 Construction Specification for Sodding
- TS 5.10 Construction Specification for Growing Medium
- TS 5.30 Construction Specification for Planting

Construction Specification for Sodding

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TS 5.00.01 SCOPE

This specification covers the requirements for the supplying, placing, and maintaining sod within the contract limits.

TS 5.00.02 REFERENCES

This specification refers to the following standards, specifications or publications:

City of Toronto Specifications

TS 5.10 Construction Specification for Growing Medium

Canadian Nursery Landscape Association

CNLA Canadian Standards for Nursery Stock

TS 5.00.03 DEFINITIONS – Not Used

TS 5.00.04 DESIGN AND SUBMISSION REQUIREMENTS

TS 5.00.04.01 Delivery and Storage

Schedule deliveries in order to keep storage at job site to a minimum without causing delay.

Deliver and store sod on pallets on site within 24 hours of being lifted.

During wet weather allow sod to dry sufficiently to prevent tearing during lifting and handling.

During dry weather protect sod from drying and water sod as necessary to ensure its vitality and prevent dropping of soil in handling. Dry sod shall be rejected.

Broken, dry, discoloured pieces shall be rejected by the Contract Administrator.

TS 5.00.05 MATERIALS

TS 5.00.05.01 Nursery Sod

The quality and the source of nursery sod supplied shall be according to the specifications for number one grade turf grass nursery sod as set out in the latest edition of *Canadian Standards for Nursery Stock*. It shall be Number One Kentucky Bluegrass or Kentucky Bluegrass/Fine Fescue cultivars or as specified in the Contract Documents.

The source of sod shall be approved by the Contract Administrator before it is used in the Contract. No other source shall be used without the approval of the Contract Administrator.

TS 5.00.05.02 Sod Stakes

Sod stakes shall be wooden pegs 17 x 17 x 300 mm or approved 200 mm long steel staples.

TS 5.00.05.03 Fertilizer

Fertilizer shall be a complete synthetic slow release fertilizer with maximum 35 per cent water soluble nitrogen. Apply fertilizer at rates based on soil analysis recommendations.

TS 5.00.05.04 Water

Potable water shall be used, unless the Contractor provides testing results that demonstrate the water to be used is free of contaminants or impurities that would adversely affect the germination and growth of vegetation

TS 5.00.05.05 Mesh

Mesh shall be jute or synthetic plastic.

TS 5.00.05.06 Herbicide

Type, rate, and method of application subject to approval by the Contract Administrator, and shall be according to Toronto Municipal Code Chapter 612 Pesticides, Use of.

TS 5.00.05.07 Topsoil

Topsoil shall be 100 mm in depth and be Type 1 – Standard Mix according to TS 5.10.

TS 5.00.06 EQUIPMENT – Not Used

TS 5.00.07 CONSTRUCTION

TS 5.00.07.01 Workmanship

Keep site well drained. Clean up immediately any soil and debris spilled onto pavements and dispose of deleterious materials.

TS 5.00.07.02 Preparation of Topsoil Substrate

Verify that grades are correct. If discrepancies occur, notify the Contract Administrator and do not commence work until instructed by Contract Administrator

Remove debris, roots, branches, stones in excess of 50 mm diameter and other deleterious materials. Remove soil contaminated with calcium chloride, toxic materials and petroleum products. Remove debris which protrudes more than 75 mm above surface. Dispose of removed material off site.

Cross cultivate those areas where equipment used for hauling and spreading has compacted soil.

Where new sod is to be installed in existing sodded areas not disturbed by construction, rototill the area, apply a topdressing of topsoil, and install sod as specified.

TS 5.00.07.03 Laying of Sod

Prior to sodding, obtain approval from Contract Administrator that finished grade and depth of topsoil are satisfactory.

Lay sod within 36 hours of being lifted.

Sodding during excessively wet conditions, at freezing temperatures or over frozen soil is not acceptable.

Lay sod in rows, perpendicular to slope, and with joints staggered. Butt sections closely without overlapping or leaving gaps between sections. Cut out irregular or thin sections with sharp implements.

Provide close contact between sod and soil by light rolling. Use of heavy roller to correct irregularities in grade is not permitted.

Water sod immediately after laying to obtain moisture penetration into top 75 mm of topsoil/growing medium.

Provide adequate protection of sodded areas against erosion and mechanical damage. Remove protection after lawn areas have been accepted.

TS 5.00.07.04 Layering of Pegged Sod

Place mesh on top of topsoil on slopes steeper than 3H:1V. Secure mesh in place with wooden pegs or staples at maximum intervals of 600 mm. Cover with topsoil/growing medium.

Lay sod sections perpendicular to slopes greater than 4H:1V and secure with wooden pegs. Place pegs 3 per m, 100 mm below top edge of sod roll to prevent shifting of sod. Drive pegs flush with top of sod soil.

TS 5.00.07.05 Maintenance of Sod

Water the sodded areas in sufficient quantities and at frequency required to maintain soil under sod continuously moist to depth of 75 to 100 mm.

Cut grass when height is above 65 mm and maintain to a 60 mm – 100mm height. Remove clippings longer than 20 mm in length.

Maintain sodded areas weed free.

Fertilize sodded areas one month after sodding with fertilizer at rate per soil analysis recommendations. Postpone fertilizing until following spring if application falls within four week period to expected end of growth season.

Overseed with perennial rye and fescue grass blends (excluding creeping fescue) in the fall.

TS 5.00.07.06 Maintenance Period

The Contractor shall maintain the sod for 60 Days following completion of the sod placement. During this period, the Contractor shall ensure that all placed sod is kept healthy, actively growing and green in leaf colour. At the end of the 60-day period, the Contractor Administrator will inspect the placed sod for defects. Any defective sod shall be replaced at no extra cost to the City.

Maintenance of the placed sod should be suspended during the winter dormant period (November 1 to April 30) and the 60-day maintenance period shall resume in the following spring after the winter dormant period.

The completed sod is subject to a general warranty period as specified in the Contract Documents, notwithstanding the 60-day maintenance period mentioned in this specification.

TS 5.00.08 QUALITY ASSURANCE

TS 5.00.08.01 Performance Measure

Sixty days after installation, the sod shall be green and show evidence of rooting into the underlying soil. Any areas of sod which fail to meet these requirements shall be rejected and the Contractor shall replace the rejected sod at no extra cost to the City.

Sodded areas will be considered meeting the performance measure provided that:

- 1) Sodded areas are properly established, healthy, actively growing, and green in leaf colour.
- 2) Sod is free of bare and dead spots and without weeds.
- 3) No surface soil is visible when grass has been cut to height of 40 mm.
- 4) Sodded areas have been cut minimum 2 times.
- 5) All placed sod shall be in the same location as originally placed and shall not have moved, eroded, slipped or slough. Lawns sodded after September 30 shall be accepted in the following spring one month after start of the growing season provided acceptance conditions are fulfilled.

TS 5.00.08.02 Failure to Meet Performance Measure

If the completed work does not meet the performance measures, the Contractor shall re-apply the specified materials according to this specification. All replaced sod shall be subject to a further maintenance period of 60 consecutive days.

If the Contractor cannot apply or re-apply the sod due to site condition of for any reason, the Contractor shall maintain the site and control erosion until conditions permit application of the sod.

TS 5.00.09 MEASUREMENT FOR PAYMENT

TS 5.00.09.01 Nursery Sod – Unstaked

Measurement of nursery sod shall be by area in square metres (m²).

TS 5.00.09.02 Nursery Sod – Staked

Measurement of nursery sod and stakes shall be by area in square metres (m²).

TS 5.00.09.03 Nursery Sod – Staked with Mesh

Measurement of nursery sod, stakes and mesh shall be by area in square metres (m²).

TS 5.00.10 BASIS OF PAYMENT

TS 5.00.10.01 Nursery Sod – Unstaked – Item
Nursery Sod – Staked – Item
Nursery Sod – Staked with Mesh – Item

Payment at the Contract Price for the above tender items shall be full compensation for all labour, Equipment and Material to do the work. Payment shall include the supplying and placing of topsoil, sod, watering, weeding, fertilizing and maintenance until Final Acceptance, as well as, sod replacement and water for sod when no separate item for payment exists for such work.

Construction Specification for Growing Medium

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TS 5.10.01 SCOPE

This specification describes the requirements for the following:

- 1) Requirements for reuse of existing site soil as growing medium.
- 2) Mixing and testing of topsoil, coarse sand and compost components to create several different types of growing medium, applicable for the following applications:
 - Type 1 – Standard Mix, for seeding, sodding and trees planted in turf
 - Type 2 – Planting Bed Mix, for planting of shrubs and perennials
 - Type 3 – Boulevard Mix, for trees planted in hardscaped boulevards
 - Type 4 – Bioretention mix, for bioretention and rain gardens requiring high infiltration or pre-treatment.
- 3) Installation of growing medium.
- 4) Compacting and grading of growing medium.
- 5) Adding organic material to the surface layer of growing medium.

TS 5.10.02 REFERENCES

This specification refers to the following standards, specifications or publications:

City of Toronto Standard Specifications

TS 853 Construction Specification for Soil Cells

American Society of Testing and Materials

C33/C33M	Standard Specification for Concrete Aggregates
D422-63(2007)e1	Standard Test Method for Particle-Size Analysis of Soils
D2434	Standard Test Method for Permeability of Granular Soils (Constant Head)
D6913/D6913M	Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
D7503	Standard Test Method for Measuring the Exchange Complex and Cation Exchange Capacity of Inorganic Fine-Grained Soils
F1632	Standard Test Method for Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Rootzone Mixes
F1647	Standard Test Methods for Organic Matter Content of Athletic Field Rootzone Mixes
F1815	Standard Test Methods for Saturated Hydraulic Conductivity, Water Retention, Porosity, and Bulk Density of Athletic Field Rootzones

American Society of Agricultural Engineers

EP542 Procedures for Using and Reporting Data with the Soil Cone Penetrometer.

Canadian Council of Ministers of the Environment

Guidelines for Compost Quality (PN 1340) 2005

Compost Quality Alliance

TMECC Test Method for the Examination of Composting and Compost

Ontario Ministry of the Environment

Guideline for the Production of Compost in Ontario, Companion to the Ontario Quality Standards (July 2012)

Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act (April 2011)

TS 5.10.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

CSSS means Canadian System of Soil Classification

USDA means US Department of Agriculture

Agricultural Soil means manipulated and managed soils for the purposes of maximizing plant growth.

Continuous Soil Trench (CST) means a structure designed and built to contain an adequate volume of continuous growing media to support tree growth to maturity under a paved boulevard.

Scarification means the breaking down of a hydrophobic layer to increase infiltration rate (not advisable however sometimes necessary in compacted uncovered soils).

Soil Fracture means breaking of soil via mechanical or erosive processes.

Soil Ped means soil peds are soil aggregates built over time via natural processes – air, water, microorganisms – that give the soil its structure.

Stormwater Tree Trench (STT) means a continuous soil trench that is designed to capture, infiltrate and filter stormwater runoff from a drainage area beyond the footprint of the trench.

Till means generally, this is the mechanical process by which soil is broken up. Various means can be used to till ranging from hand equipment such as a spade/rake to intensive mechanized equipment. The term is used here to refer to the process of loosening the surface of the native soil so that it mixes with the growing medium.

Topsoil means topsoil is a nutrient-rich layer of soil that is naturally occurring and characterized by a high concentration of organic matter and microorganisms. Topsoil, sand and compost are the components of growing medium.

Tree Protection Zone (TPZ) means an area around a protected tree, the size of which relates to the diameter of the tree trunk. Protection is governed by the City's tree-related bylaws. For more information, refer to www.toronto.ca/services-payments/building-construction/tree-ravine-protection-permits/tree-protection/

Turf means turf, also known as sod, is grassy mat held together by its roots and a thin layer of soil.

TS 5.10.04 DESIGN AND SUBMISSION REQUIREMENTS

TS 5.10.04.01 Submittals

TS 5.10.04.01.01 Checklist

For checklist form, see *Contractors Submittal Checklist* form, at the end of this specification section. This list is a summary of the requirements and is not intended to supplant or modify the detailed descriptions of the requirements below. Note that many of the submittals must be provided a minimum of eight weeks before the installation of growing medium.

TS 5.10.04.01.02 Certificates

Submit certification to the Contract Administrator for approval that all growing medium components and the growing medium meet all environmental standards of the Province of Ontario and the City of Toronto. Certificate shall state that all materials are within the required maximum levels of all biological, metal and chemical contaminants.

TS 5.10.04.01.03 Product Data

Submit manufacturer product data and literature to the Contract Administrator for approval for coarse sand, aggregate, pine bark compost and yard waste compost. Provide submittal as part of the submittal of components for the growing medium prior to the submission of the growing medium.

Submit the manufacturer's particle size analysis, pH and the manufacturer's Fines Modulus Index for coarse sand. Provide manufacturer's identification and location for each coarse sand source.

Submit the manufacturer's pine bark compost and yard waste compost analysis for approval. Chemical and physical testing shall be conducted by soil laboratories accredited by The Compost Quality Alliance (CQA) utilizing test methods specified in The Test Methods for Examination of Composting and Compost (TMECC) except as specified herein.

Samples of each material shall be submitted at the same time as the product data and testing data of that material. Samples and analysis of topsoil, and growing medium must be submitted within 45 days prior to installation.

The compost analysis shall include:

Table 1: Compost analysis

Parameter	Testing Method
pH	TMECC 4.11A
soluble salt (mmhos/cm)	TMECC 4.10-A
% moisture	
% dry weight organic matter	TMECC 5.07-A
carbon: nitrogen	(C:N) ratio
particle size % passing 50 mm and 10 mm	TMECC 2.02-B
Solvita maturity index	Solvita
physical contaminants (% dry weight)	TMECC 3.08-A

Submit testing for chemical and biological contaminants and pathogens as required by local government regulations.

Certified reports shall be from samples taken within four months of the date of the sample submission.

TS 5.10.04.01.04 Material Source Locations

Submit locations of topsoil and growing medium material sources to the Contract Administrator. The City shall have the right to reject any material source. Submit the name, address and telephone number of the source contact, and the location of the soil source including directions to the specific field location on the property.

Include a list of all crops grown on the soil, and any herbicides and pesticides applied, over the previous three years (if applicable).

TS 5.10.04.01.05 Samples

Submit samples of each product and material where required by the specification to the Contract Administrator for approval. Label samples to indicate product, specification number, characteristics, and locations in the Work. Samples shall be reviewed for appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor. Delivered materials shall closely match the samples.

For in-situ soils, a minimum of three samples shall be analyzed if less than 600 m³ of soil is installed. If more than 600 m³ is installed a minimum of one test will be taken for each 200 m³ above 600 m³.

Submit duplicate samples for each of: topsoil, coarse sand, aggregate, pine bark compost, yard waste compost and growing medium, as described in this clause.

Samples should be labeled to include the location of the source of the material.

Samples of each material shall be submitted at the same time as the product data and testing data of that material. Samples and analysis of topsoil, and growing medium must be submitted within 45 days prior to installation. Contract administrators may request three (3) test results for final mix designs if deemed necessary.

Each test report shall be marked with the following information:

- 1) Date issued;
- 2) Project title and names of Contractor and material supplier;
- 3) Name of material and reference number from TS 5.10.05, herein, identifying the type of material;
- 4) Date, place, and time of sampling;
- 5) Location of material source;
- 6) Testing laboratory name, address, and telephone number, and name(s), as applicable, of each field and laboratory inspector;
- 7) Type(s) of test;
- 8) Results of test(s); Suggested acceptable ranges of the test data for the types of plants to be planted; preference given to laboratories that can provide this range information.
- 9) Recommendations for amendments to bring the growing medium to within these acceptable ranges; Note: This direction does not guarantee subsequent testing will yield results within ranges. This does not necessarily require retest prior to approval.
- 10) Soil testing parameters should reflect parameters identified within specifications.

Samples of growing medium shall be submitted no less than 14 days after the approval of the mix components.

Do not submit samples of growing medium for approval until all mix component testing has been reviewed and approved by the Contract Administrator.

TS 5.10.04.01.06 Testing Reports

Submit soil test analysis report to the Contract Administrator for approval for each sample of topsoil and growing medium from an approved soil-testing laboratory, as below:

The testing laboratory shall be approved by the City in advance. All soil and growing medium tests shall be conducted by soil laboratories accredited by The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), except as noted below. Current listing of accredited laboratories can be found at www.omafra.gov.on.ca/english/crops/resource/soillabs.htm. Submit the name of the soil lab for approval prior to starting the testing process. Preference given to laboratories that can provide acceptable test data ranges for the types of plants being planted.

All tests shall be performed in accordance with the current testing standards and protocols of the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA).

Particle size distribution analysis for all topsoil and growing medium including the following gradient of mineral content:

Table 2: Particle size distribution

CSSS/USDA designation	Size (mm)
Gravel	2 – 75
Total sand	0.05 – 2
very coarse sand	1 – 2
coarse sand	0.5 – 1
medium sand	0.25 – 0.5
fine sand	0.1 – 0.25
very fine sand	0.05 – 0.1
Silt	0.002 – 0.05
Clay	< 0.002

Note: Contractors should note that where test results fall outside of specified ranges, the Contract Administrator will examine the extent of variance, as well as any recommendations from the testing laboratory, and determine whether the soil will be accepted, amended or rejected.

Particle size analysis and growing medium to include sand sieve analysis, and shall be according to ASTM D6913/D6913M, (PSD of soil by sieve analysis), ASTM D422 (hydrometer test) or ASTM F1632 (pipette test) or equivalent.

Chemical analysis including the following:

- 1) pH
- 2) Plant available nutrient levels by parts per million including:
 - Phosphorus
 - Potassium
 - Magnesium
 - Calcium

For chemical analysis of Phosphorus, use the Olsen method for alkaline and calcareous soils. Use the Bray or Mehlich I or III method for acidic to slightly alkaline and non-calcareous soils.

Nutrient test shall include the testing laboratory recommendations for supplemental additions to the growing medium:

- 1) Soluble salt by electrical conductivity of a 1:2 soil water sample measured in mmhos/cm;
- 2) Cation Exchange Capacity (CEC) measured in meq/100g (ASTM D7503, Cation Exchange Capacity);
- 3) Percent Organic Matter by dry weight as determined by ignition (Ash Burn Test or Walkley/Black Test, ASTM F1647); and
- 4) Carbon to Nitrogen (C:N) ratio.

For Type 3 – Boulevard Mix, Type 4 – Bioretention Mix, and for soils used in green infrastructure applications Infiltration/Permeability/Hydraulic Conductivity testing shall be done using ASTM D2434 or ASTM F1815. Testing methodology utilized shall reflect desired, in-situ compaction levels.

Report suitability of topsoil or growing medium for growth of applicable planting material. Soil analysis tests shall include recommendations for normal ranges of soil chemical attributes for the type of plants included in the project in the same units as the test data.

The City may request additional growing medium test on different mix component ratios in order to attain results that more closely meet the mix requirements.

Laboratory comments or recommendations regarding amendment requirements or procedures shall not be interpreted to prescribe or dictate procedures or quantities of soil materials for the work of this Contract. Final approval of soil amendment procedures shall be approved by the Contract Administrator.

The City reserves the right to require additional soil analysis at any time such additional samples of materials are deemed necessary for verification of conformance to specification requirements.

Contractor shall furnish samples for this purpose upon request and shall perform and pay for additional testing as requested by the Contract Administrator at no extra cost to the City.

Contractor to arrange for testing at start of project. All testing shall be at the expense of the Contractor.

TS 5.10.04.01.07 In-Situ Compaction Testing

Submit results of all compaction testing required by the specifications to the Contract Administrator for approval.

- 1) Installed growing medium shall be tested in-situ with a cone penetrometer and a soil moisture meter.
 - a) Testing shall be arranged for and paid for by the Contractor.
 - b) Acceptable procedures for performing and interpreting the results of cone penetration tests on soils using a mechanical or electronic static cone penetrometer are provided in the American Society of Agricultural Engineers' Standard EP542.
 - c) Cone penetration tests shall be performed after wetting and allowing a min. of one week settling. Penetration resistance shall be to the full depth of the installed soil profile or 750 mm, whichever is less, when the soil profile is thoroughly wetted and confirmed by in-situ measurements using a soil moisture meter and the following acceptable ranges:

Soil texture	Soil moisture
sand, loamy sand, sandy loam	12–18%
loam, sandy clay, sandy clay loam	27–36%
clay loam, silt loam	31–36%
silty clay, silty clay loam	38–41%

-
- d) One test shall be performed every 25 m² of growing medium surface area. The City may request additional testing locations.
 - 2) Maintain a record log of all compaction testing for submission and approval. The record log shall include the date, location, depth and pressure reading of each test. Test location data shall be plotted on a site plan.
 - 3) Submit the compaction log to the City at the end of installation period. The compaction log shall be kept current and available at the site for review at all times.

TS 5.10.04.02 Sequencing and Scheduling

Prepare a detailed schedule of the installation of growing medium for coordination with other trades, and submit to the City for approval prior to the start of the project.

Sequence delivery and installation of growing medium so that it can be adequately protected from other work at the site.

Schedule all sub-surface utility installation so that it is completed prior to delivery and installation of growing medium.

TS 5.10.04.03 Delivery, Storage and Handling

Do not mix, deliver or place growing medium in frozen, wet, or muddy weather conditions.

Where construction sequencing requires work during cold weather, protect sub grades and bulk materials from freezing using covers or heated tenting as needed. Sub grades that are sufficiently well drained to preclude the buildup of ice may be installed and built upon during freezing weather provided the surface is cleared of snow and any ice bound material.

Harvest topsoil and prepare growing medium ahead of the scheduled work during periods of warm weather.

Stockpiles should not exceed a height of 1.4 m.

Protect stockpiles of topsoil and growing medium from freezing and saturation. Remove topsoil from within the interior of the stockpile where topsoil and growing medium are not frozen. At the end of each day cover the exposed working face of the stockpile sufficient to keep from freezing.

Protect stockpiles from rain and washing that can separate fines and coarse material, and from wind erosion. Cover stockpiles with plastic sheeting at the end of each workday and ensure covering is secured in case of windy conditions. When possible, uncover stockpiles daily during warm dry conditions, to ensure breathability.

Protect growing medium stockpiles from contamination by chemicals, dust and debris that may be detrimental to plants or drainage.

Do not use delivery or installation methods that overly mix the growing medium. Soil blowing equipment shall not be permitted to move growing medium.

TS 5.10.04.04 Site Conditions

It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to report any circumstances that will negatively impact drainage. Do not proceed with the work until unsatisfactory conditions have been corrected.

TS 5.10.04.04.01 Utilities

Determine location of all utilities including vaults, conduits, pipes and wires adjacent to, below or within the areas of work. Perform all work in a manner, which will avoid damage to any utility. Hand excavate near any utility.

For any continuous soil trench or stormwater tree trench, rely only on utility information that has been obtained and described to Quality Level A as defined by the American Society of Civil Engineers standard ASCE 38-02, including certification by a civil engineer, licensed in the province of Ontario.

TS 5.10.04.04.02 Waterproofing

Perform work in a manner, which will avoid damage to waterproofing membrane, protection board or other structural sealing materials.

TS 5.10.04.04.03 Coordination

Coordinate work with that of other trades affecting or affected by work of this section and cooperate to assure the steady progress of work.

TS 5.10.04.04.04 Safety

The Contractor shall be responsible for pedestrian and vehicular safety and control all movement within and around the work site. Provide the necessary barriers, warning devices and ground personnel needed to give safety, warning and protection to persons and vehicular traffic within the area of work including the Contractor's equipment and temporary storage within the public right-of-way. Provide any additional items required by the City.

TS 5.10.04.04.05 Damage

During site preparation, growing medium installation and protection, the Contractor shall be responsible for all damage to existing features above and below ground incurred as a result of work operations. Repairs or replacements or both shall be made to the satisfaction of the Contract Administrator.

Protect all installed material from compaction, contamination and erosion. Install fences; utilize mulch, mats and geo-fabrics over the surface of the soil as required. In the event that any soil becomes compacted, contaminated or eroded, repair the damage by removing and reinstalling the compacted material according to TS 5.10.07.11, herein.

TS 5.10.05 MATERIALS**TS 5.10.05.01 Topsoil Component**

Topsoil shall be naturally occurring soil, harvested from the O or A horizon of the soil profile, suitable for the germination of seeds and the support of vegetative growth, and meet the following requirements:

Soil particle size distribution	
Sand (0.05 – 2 mm)	20 – 70%
Silt (0.002 – 0.05)	<i>Total SSC will sum 100%</i>
Clay (<0.002 mm)	
	15 – 30%
Chemical analysis	
	pH: 5.5 – 7.8 ⁽¹⁾
Plant Available Nutrient Levels (ppm)	
Phosphorous	10 – 60
Potassium	80 – 250
Calcium	< 5000
Magnesium	100 – 300
Soluble salt	< 0.50 mmhos/cm
Sodium Adsorption Ratio	<15
Cation Exchange Capacity (CEC)	> 20 meq/100g
Percent organic matter	2.5 – 5%

Notes: Specifiers should note that the pH maximum of 7.8 will be acceptable for most trees and other plants in the Toronto area. However, if the design team specifies pH sensitive trees or plants, the pH maximum should be lowered to an appropriate level for those plants. Note that lower pH growing medium will cost more due to the lack of availability of lower pH components. Coordinate the specification with the design team regarding plant species requirements.

Contractors should note that where test results fall outside of specified ranges, the Contract Administrator will examine the extent of variance, as well as any recommendations from the testing laboratory, and determine whether the soil will be accepted, amended or rejected.

Topsoil shall retain a significant portion of the soil's ped structure when stockpiled at the supplier's yard. Peds are defined as the clumps of soil naturally aggregated during the soil building process, by clays and soil biology. Peds of any size are permissible.

The Contract Administrator shall evaluate the presence of peds by visual examination of the sample submitted. The addition of coarse sands and organic amendments may reduce the presence of peds.

Topsoil shall not be screened through sieves or screens smaller than 50 mm to avoid eliminating soil peds.

Topsoil shall not contain materials and contaminants at levels that would be detrimental to plant growth; or impair drainage, installation or maintenance of the resulting growing medium; or adversely impact its intended use including containing the following

- Refuse; roots; construction debris; wood or sticks larger than 25 mm in diameter; brush; clumps of root mats of plants and toxic materials
- Lumps of clay or subsoil larger than 50 mm
- Stones larger than 75 mm
- Deleterious substances; plant or soil pests; undesirable grasses including crabgrass or couch grass, noxious or weeds or weed seeds.

The City shall determine if the quantities of any of these materials is sufficient to cause rejection of the topsoil. The aggregate of all the above materials shall not exceed 5 per cent of the total soil volume as assessed by visual inspection.

Topsoil shall be in according to Toronto Municipal Code Chapter 489, Grass and Weeds. The contractor shall be responsible for removing all weeds that germinate during the plant maintenance period.

Topsoil shall be harvested from approved source locations that comply with all regulations governing the removal of topsoil.

Topsoil may be purchased from a source of collected topsoil from development sites provided the sources of the topsoil stockpile is of similar textures and meets the requirements of this specification.

Topsoil shall not be a soil mix including any combination of sand, fertilizer, or organic matter or compost added to mineral soil in order to meet the texture, chemical or organic requirements for topsoil. The organic matter content of the soil shall be residue of long term, natural soil building processes and not from added organic matter or compost.

Submit source location and a list of all crops grown on the soil and any herbicides and pesticides applied over the previous three years, if applicable.

Submit duplicate 4 L samples (total 8 L) from each topsoil source with soil testing results. The sample shall be a mixture of the random samples taken around the source field or stockpile. The delivered sample shall represent the soil ped content in the stockpile.

TS 5.10.05.02 Coarse Sand Component

Coarse sand shall be clean, sharp, mineral sand, and meet the following requirements:

Coarse concrete sand, ASTM C33 with a Fines Modulus Index between 2.5 and 3.5

Table 3: Physical analysis

Sieve size (mm)	Per cent passing
9.5	100
4.75	95 – 100
2.36	80 – 100
1.18	50 – 85
0.60	25 – 65
0.30	5 – 30
0.15	0 – 10
0.075	≤ 3

Note: Contractors should note that where test results fall outside of specified ranges, the Contract Administrator will examine the extent of variance, as well as any recommendations from the testing laboratory, and determine whether the soil will be accepted, amended or rejected.

Chemical analysis shall be as follows:

- 1) pH <8.6
- 2) Soluble Salt < 0.5 mmhos/cm
- 3) Percent Organic Matter < 0.5%
- 4) Local sources preferred

Coarse sand shall not contain toxic substance at levels harmful to plant growth.

Submit duplicate 1 L (total 2 L) samples with manufacturer's literature and material testing certification that the product meets the above requirements.

TS 5.10.05.03 Organic Component

Compost shall be a stable, humus-like material produced from aerobic decomposition, composted and cured until the maturity status complies with indices specified below. Except as specified herein, compost shall be according to the requirements for Category A Compost as defined in the Guidelines for Compost Quality.

- Yard waste compost feedstock shall be yard waste trimmings or source-separated municipal solid waste or both.
- Pine bark compost feedstock shall be 98 per cent pine trees with less than 10 per cent combined pine wood fiber and sawdust content.
- Untreated shredded wood / wood chips.

Compost shall not contain weeds or debris such as sharp objects, plastics, trace elements and foreign matter in excess of that defined for Category A Compost. Total of all stones, recognizable branches, wood chips and roots larger than 25 mm in diameter shall be less than 5 per cent by volume.

Compost shall have moisture content between 35 and 55 per cent when blended or applied.

Compost shall be composted long enough to exhibit a dark brown color, approximately Munsell colour 7.5 R; Value 3 or lower; Chroma 2 or lower. Color shall be determined by visual comparison of the sample to the Munsell Soil Color Chart, most current edition.

Compost shall have a strong aerobic (sweet) odor. Compost lacking a strong aerobic odor or which has an anaerobic (sour) or a strong pine or alcohol odor shall be rejected. Odor may be determined during the submittal sample review and at the time of any inspections of materials by the Contract Administrator by observation of the inspector.

Certification: provide the following documentation to the Contract Administrator:

- 1) A statement that the compost meets all health and safety regulations.
- 2) Feedstock type and percentage in the final compost product.

Testing: Compost shall be tested every 4000 m³ of material intended for use in growing medium. The results of compost analysis shall be provided by the compost supplier for approval. Compost should meet the following criteria as reported by the following laboratory tests:

Physical analysis

Particle size yard waste compost	95% pass through 50 mm screen
	25% pass through 10 mm screen
Particle size pine bark compost	95% pass through 20 mm screen
	25% pass through 6 mm screen

Chemical analysis

Parameter	Range
pH yard waste compost	5.0 – 8.0
pH pine bark compost	4.0 – 6.5
soluble salt	< 3.5 mhos/cm
% moisture	35 – 55%
% organic matter	25 – 55%
Solvita maturity index	Solvita
C:N ratio	15:1 – 25:1 (for Yard Waste only)

Note: Contractors should note that where test results fall outside of specified ranges, the Contract Administrator will examine the extent of variance, as well as any recommendations from the testing laboratory, and determine whether the soil will be accepted, amended or rejected.

Physical contaminants (including man-made inerts) < 1 per cent dry weight basis

Metal content shall comply with Guidelines for the Production and Use of Aerobic Compost in Ontario except for copper and zinc, which must comply with Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act Table 3 (medium to fine textured soils).

Pathogen reduction shall meet Section 6.0 of Guidelines for the Production and Use of Aerobic Compost in Ontario.

Submit duplicate 1 L samples (total 2 L) with manufacturer's literature and material testing certification that the product meets the requirements.

TS 5.10.05.04 Existing Site Soil as Growing Medium

Existing site soil for seeding, sodding and tree planting may be used as growing medium at sites where the existing soil has been analyzed by an agricultural soil scientist and determined to be suitable for its intended purpose. The City may approve the use of existing soils and may require additional amendments for the soil where recommended by the soil report.

Soils that would not be suitable include: subsoils, soils with high clay or silt content, with very high or low pH, contaminated with chemicals and/or salt, or which have been mixed with gravels or unshrinkable fills.

The following are requirements for existing site soil to be used as growing medium.

Soil particle size distribution	
Sand (0.05 – 2 mm)	20 – 70%
Silt (0.002 – 0.05)	<i>Total SSC will sum 100%</i>
Clay (<0.002 mm)	15 – 30%
Gravel (2 – 75 mm)	< 5%
Chemical analysis	pH: 5.5 – 7.8
Plant Available Nutrient Levels (ppm)	<i>If not balanced follow lab recommendations for fertilizer application subsequent to installation</i>
Phosphorous	10 – 60
Potassium	80 – 250
Calcium	< 5000
Magnesium	100 – 300
Soluble salt	< 2 mmhos/cm
Percent organic matter	2.5 – 5%
Infiltration/Permeability/Hydraulic Conductivity	50 –75 mm/hr at 85% Proctor density

Submit duplicate 4 L samples (total 8 L) with material testing certification that the product meets the requirements.

Submit the agricultural soil scientist report for approval. The report shall describe the extent and depth of the soil to be reused, and the soil quality relative to the required parameters. It is understood that obtaining accurate soil information in urban areas is difficult if there is paving over the soil. A preliminary soil report shall be submitted a minimum of eight weeks prior to the installation of the soil. Once the soil has been made accessible by the construction, the soil shall be reevaluated and a final report submitted. Urban Forestry may alter the approval or make additional requirements based on the final soils report.

The depth of the existing topsoil should be checked throughout the site and documented prior to harvesting from the site to help guide soil replacement depths.

- 1) Topsoil salvage limits shall be to a depth of one metre or as specified in the Contract Documents.
- 2) Document the plant communities with which the topsoil is associated.
- 3) Proceed from higher to lower topographic areas when stripping topsoil.
- 4) Remove topsoil as late as possible in the construction sequence.
- 5) Any objects or debris, such as segments of concrete, asphalt, brick or unshrinkable fill, or soil mixed with gravel, dust or other debris, shall be removed, and the soil volume replaced with new topsoil mixed into the existing soil, to the satisfaction of the Contract Administrator.

Existing site soil to be reused shall be excavated to break up compaction and reinstalled at the compaction required for growing medium.

Do not screen topsoil prior to stockpiling. The excavated topsoil should be placed into stockpiles at locations designated on the construction drawings. Stockpiles should be treated with temporary soil stabilization and erosion control measures. Do not cover stockpiles with plastic or other non-breathable materials.

Stockpiles should not exceed 1.4 m in height.

Excavation, moving, stockpiling and installation of existing site soil shall utilize means and methods that preserve soil peds. Large soil peds up to 200 mm in any dimension are acceptable.

Yard waste compost shall be loosely incorporated into the soil at the time of installation at a rate of 20 per cent by volume.

Cover the stockpile with yard waste compost of sufficient volume to roughly equal 20 per cent of the stockpile volume. Using the bucket of a backhoe, drag the pile to approximately one-third its height. Working from the bottom, turn the pile over once. Place in the installation location following the requirements for growing medium.

Fertilizer may be added to the soil if required to meet the chemical requirements of growing medium.

Soil shall not be contaminated with toxic chemicals harmful to humans or plants at levels exceeding provincial or federal limits.

TS 5.10.05.05 Type 1 – Standard Mix

For sodding, sodding and trees planted in turf, a mixture of topsoil, coarse sand and compost components mixed in the appropriate proportions, such that the growing medium shall meet the following parameters:

Soil particle size distribution	
Total sand (0.05 – 2 mm)	50 – 75%
Silt	20 – 40% (<i>Total SSC will sum 100%</i>)
Clay	5 – 20%
Gravel (2 – 75 mm)	>/+/< 5%
Chemical analysis ⁽¹⁾	pH: 6.0 – 7.8 ⁽¹⁾
Plant Available Nutrient Levels (ppm)	
Phosphorous	10 – 60
Potassium	80 – 250
Calcium	< 5000
Magnesium	100 – 300
Soluble salt	< 1.5 mmhos/cm
Percent organic matter (dry weight)	4 – 6%
Infiltration/Permeability/Hydraulic Conductivity	50 –75 mm/hr at 85% Proctor density

Notes: ¹ Specifiers should note that the pH maximum of 7.8 will be acceptable for most trees and other plants in the Toronto area. However, if the design team specifies pH sensitive trees or plants, the pH maximum should be lowered to an appropriate level for those plants. Note that lower pH growing medium will cost more due to the lack of availability of lower pH components. Coordinate the specification with the design team regarding plant species requirements.

² Contractors should note that where test results fall outside of specified ranges, the Contract Administrator will examine the extent of variance, as well as any recommendations from the testing laboratory, and determine whether the soil will be accepted, amended or rejected.

Type 1 Mix does not necessarily require the above coarse sand or organic amendment depending on existing texture and chemical properties. Type 1 Mix reflects test results by weight and not component composition by volume as in Type 2 and 3.

Mix the growing medium with a loader bucket to preserve topsoil peds using the following method:

- Mix the coarse sand and compost together separately;

- Spread a layer of topsoil approximately 300 mm thick and apply the required proportions of coarse sand/compost mix over the topsoil;
- Push the topsoil, coarse sand and compost into a pile and then drag out into a layer mixing the soil with the bucket. Repeat the mixing action a second time to gain an approximate mixture of the material. Do not over mix;

This method assumes that there is additional mixing of the materials as it is moved to the final stockpile, placed into delivery trucks, deposited at the project site, and spread into the installation location.

This method assumes that soil will not be installed using soil blower equipment. If a soil slinger is used for installation, the belt speed should be minimized to reduce velocity such that the soil drops off the belt – water-falling, forming a pile underneath. The soil is not to be projected over a horizontal distance.

Submit duplicate 4 L samples (total 8 L) with material testing certification that the product meets the requirements.

TS 5.10.05.06 Type 2 – Planting Bed Mix

For horticultural beds of shrubs and perennials, a mixture of topsoil, coarse sand and compost mixed to the following proportions, by volume:

Topsoil	50%
Coarse sand	20%
Organic components	30%

The growing medium shall meet the following parameters:

Chemical analysis ⁽¹⁾	pH: 6.0 – 7.8 ⁽¹⁾
Plant Available Nutrient Levels (ppm)	
Phosphorous	10 – 60
Potassium	80 – 250
Calcium	< 5000
Magnesium	100 – 300
Soluble salt	< 1.5 mmhos/cm
Percent organic matter (dry weight)	4-6%
Infiltration/Permeability/Hydraulic Conductivity	50 –75 mm/hr at 85% Proctor density

Notes: ¹ Specifiers should note that the pH maximum of 7.8 will be acceptable for most plants in the Toronto area. However, if the design team specifies pH sensitive trees or plants, the pH maximum should be lowered to an appropriate level for those plants. Note that lower pH growing medium will cost more due to the lack of availability of lower pH components. Coordinate the specification with the design team regarding plant species requirements.

² Contractors should note that where test results fall outside of specified ranges, the Contract Administrator will examine the extent of variance, as well as any recommendations from the testing laboratory, and determine whether the soil will be accepted, amended or rejected.

Submit duplicate 4L samples (total 8 L) with material testing certification that the product meets the requirements.

TS 5.10.05.07 Type 3 – Boulevard Mix

For tree planting in hardscape boulevards, a mixture of topsoil, coarse sand and compost mixed to the following proportions, by volume:

Topsoil	40 – 45%
Coarse sand	40 – 50%
Organic components	12 – 15%

The growing medium shall meet the following parameters:

Soil particle size distribution	
Medium to coarse sand (0.25 – 2 mm) plus gravel (2 – 5 mm)	> 45%
Total combined silt and clay	18 – 40%
Gravel (2 – 75 mm)	> 5%
Chemical analysis ⁽¹⁾	pH: 6.0 – 7.8 ⁽¹⁾
Plant Available Nutrient Levels (ppm)	
Phosphorous	10 – 60
Potassium	80 – 250
Calcium	< 5000
Magnesium	100 – 300
Soluble salt	< 1.5 mmhos/cm
Percent organic matter	2.5 – 5%
Infiltration/Permeability/Hydraulic Conductivity	50 – 75 mm/hr at 85% Proctor density

Notes: ¹ Specifiers should note that the pH maximum of 7.8 will be acceptable for most trees and other plants in the Toronto area. However, if the design team specifies pH sensitive trees or plants, the pH maximum should be lowered to an appropriate level for those plants. Note that lower pH growing medium will cost more due to the lack of availability of lower pH components. Coordinate the specification with the design team regarding plant species requirements.

² Contractors should note that where test results fall outside of specified ranges, the Contract Administrator will examine the extent of variance, as well as any recommendations from the testing laboratory, and determine whether the soil will be accepted, amended or rejected.

All testing must reflect specified parameters, that is to say sand + gravel and silt + clay where each must be tested together and reported accordingly. For example, sand + gravel = 73%, silt + clay = 17%.

Mix the growing medium with a loader bucket to preserve topsoil peds using the following method:

- 1) Mix the coarse sand and compost together separately;
- 2) Spread a layer of topsoil approximately 300 mm thick and apply the required proportions of coarse sand/compost mix over the topsoil; and
- 3) Push the topsoil, coarse sand and compost into a pile and then drag out into a layer mixing the soil with the bucket. Repeat the mixing action a second time to gain an approximate mixture of the material. Do not over mix.

This method assumes that there is additional mixing of the materials as it is moved to the final stockpile, placed into delivery trucks, deposited at the project site, and spread into the installation location.

This method assumes that soil will not be installed using a soil blower. If a soil slinger is used for installation, the belt speed should be minimized to reduce velocity such that the soil drops off the belt–water-falling, forming a pile underneath. The soil is not to be projected over a horizontal distance.

Submit duplicate 4L samples (total 8 L) with material testing certification that the product meets the requirements.

TS 5.10.05.08 Type 4 – Bioretention mix

For bioretention and rain gardens requiring high infiltration or pre-treatment mix to the following proportions, by volume:

Topsoil	2 parts topsoil
Coarse sand	3 parts sand
Organic components	1 part organic soil components (leaf and yard waste compost and/or pine bark fines)

The growing medium shall meet the following parameters:

Media specification	Site-specific goal	
	Infiltration *Above mix proportions may need to be adjusted to accommodate a greater proportion of sand.	Treatment
Soil particle size distribution		
Sand (0.05 – 2 mm.)	75-90%	65-75%
Silt (0.002 - 0.05 mm)	7-22%	13-30%
Clay (< 0.002 mm)	3-15%	3-15%
Gravel (2.0 – 64 mm.)	less than or equal to 10%	
Chemical analysis	pH: 6.0 – 8.0	
Plant Available Nutrient Levels (ppm)		
Phosphorous	10 – 40	
Potassium	80 – 250	
Calcium	< 5000	
Magnesium	100 – 300	
Percent organic matter	3-10%	
Hydraulic conductivity, saturated, sample compacted to 75-85% maximum dry density.	0.0021-0.0083 cm/s (75-300 mm/h)	6.9 x 10-4 -0.0021 cm/s (25-75 mm/ h)
Cation exchange capacity	> 10 meq/100 g	> 10 meq/100 g

Notes: ¹ The component mix above is generated from the Sustainable Technologies Evaluation Program (STEP) for filter media:
[wiki.sustainabletechnologies.ca/wiki/Bioretention: Filter media](http://wiki.sustainabletechnologies.ca/wiki/Bioretention:_Filter_media)

² The media specifications above are generated from the CSA W-200-18 Design of Bioretention Systems.

³ Contractors should note that where test results fall outside of specified ranges, the Contract Administrator will examine the extent of variance, as well as any recommendations from the testing laboratory, and determine whether the soil will be accepted, amended or rejected.

TS 5.10.05.09 Soil Amendments

Chemicals and other materials designed to increase soil fertility as recommended in soil testing report. All products shall be delivered to the site in unopened containers and stored in a dry enclosed space suitable for the material and meeting all environmental regulations. All products shall be freshly manufactured and dated for the season in which the products are to be used.

Fertilizer for planting shall be organic fertilizer, as defined under the *Fertilizers Act*. Submit manufacturer's product literature.

Fertilizer selections shall be based on the recommendations of the soil test.

TS 5.10.06 EQUIPMENT – Not Used**TS 5.10.07 EXECUTION****TS 5.10.07.01 Site Examination**

Examine the surface grades and soil conditions for any circumstances that might be detrimental to soil drainage, such as uneven sub grades and waterproofing that may hold or pond water, deposits of construction-related waste or soil contamination, storage of material or equipment, soil compaction or poor drainage. Confirm that all utility work and installation of planter drainage has been completed and tested. Examine the grading, verify all elevations.

Confirm that all other work in the area of growing medium installation is completed. Notify the Contract Administrator in writing of any unsatisfactory conditions.

TS 5.10.07.02 Coordination with Project Work

The Contractor shall coordinate with all other trades that may impact the completion of the soil installation work. Protect installed growing medium from compaction by other trades.

TS 5.10.07.03 Grade and Elevation Control

Provide grade and elevation control during installation of growing medium. Utilize grade stakes, surveying equipment and other means and methods to assure that grades and contours are as specified on the Contract Drawings.

Maintain grade stakes until the grades have been viewed by the Contract Administrator.

TS 5.10.07.04 Site Preparation

In areas not above structure, excavate to the proposed sub grade. Maintain all required angles of repose of the adjacent materials as shown on the Contract Drawings or as required to support adjacent materials or structures. Do not over excavate compacted subgrades of adjacent pavement or structures. Remove all construction debris and material.

Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope parallel to the finished grade or toward the subsurface drain lines as shown on the Contract Drawings.

Do not proceed with the installation of growing medium, until all subsurface utility work in the area has been completed.

Do not begin growing medium installation until all subsurface drainage, and irrigation main lines shown on the Contract Drawings are viewed and approved by the City.

Protect adjacent walls, walks and utilities from damage or staining by the soil. Use 12 mm plywood or plastic sheeting or both to cover existing concrete, metal and masonry work and other items as directed during the progress of the work.

- 1) Clean up any soil or other materials spilled on any paved surface, including at the end of each working day.
- 2) Any damage to the paving or architectural work shall be repaired by the Contractor at no extra cost the City.

TS 5.10.07.05 Growing Medium Installation

For installation of soil in soil cells, see TS 853.

Prior to installing any growing medium, the Contract Administrator shall approve the condition of the subgrade and the previously installed sub grade preparation and the installation of subsurface drainage material.

In areas of soil installation above existing subsoil, till the growing medium into the bottom layer of subsoil.

- 1) Loosen or till the subsoil of the subgrade to a depth of 50 to 75 mm with a backhoe or other suitable device.
- 2) Spread a layer of the specified growing medium 50 to 75 mm deep over the subgrade.
- 3) Soil slingers may be used for growing medium delivery/installation; however, the belt speed shall be minimized to reduce velocity such that the soil drops off the belt—water-falling, forming a pile underneath. The soil is not to be projected over a horizontal distance. If access is limited, the growing medium shall be transported in lifts from the delivery pile to the soil installation location by means causing the least amount of disturbance / compaction, for example transport by front-end loader. Growing medium shall not be installed using soil blower equipment.
- 4) Till the native soil to loosen it. A best practice is to use a manual rake to till the excavation and prepare it for growing medium installation. Take care not to over-till as this causes clumping, compaction, and detrimentally affects soil biota, such as earthworms and fungal hyphae. Then, thoroughly till a thin lift of the growing medium and the subgrade together.
- 5) Protect the tilled area from traffic. Do not allow the tilled sub grade to become compacted or wet.

Immediately install the remaining growing medium in 300 to 400 mm lifts to the required depths. Work outward from the installed growing medium such that equipment does not have to pass over the installed soil.

The depths and grades shown on the drawings are the final grades after settlement and shrinkage of the organic material. The Contractor shall install growing medium to a level of at least 50 mm above the finished grades as specified in the Contract Drawings to anticipate this reduction of growing medium volume depending on the typical settling properties of the specified growing medium.

Avoid compacting the growing medium as much effort and cost is needed to rectify such damage.

Utilize grading and earth moving equipment that uses low impact tracks that is rated to exert a static force on the ground of no more than 20 kg/m². All equipment used to install soil shall have buckets equipped with teeth to loosen soil compaction.

When any equipment passes over previously prepared subgrade or installed soil it shall reverse out of the soil area over the same path dragging the teeth of the bucket over the tracks to break surface compaction created by the equipment.

Coordinate the installation of water harvesting system and drain lines within the growing medium.

TS 5.10.07.06 Growing Medium Compaction

Provide adequate equipment to achieve consistent and uniform compaction of the growing medium. Use the smallest equipment that can reasonably perform the task of spreading and compaction.

Maintain moisture conditions within the growing medium during installation to allow for satisfactory compaction. Suspend installation operations if the growing medium becomes wet. Soils are generally identified as wet when soil moisture content exceeds 20 per cent. Moisture contents of 35 to 45 per cent are generally considered to be saturated. Do not place growing medium on wet or frozen sub grade.

Lightly compact each 300 to 400 mm lift to achieve the following test results.

Growing medium compaction shall be tested at each lift using a cone penetrometer to between 70,000 and 140,000 kg/m² when the soil is between 12 and 20 per cent moisture.

Maximum penetration resistance readings that exceed the following values indicate that the soil has been compacted to a degree that limits plant growth and the need to take corrective action to loosen the planting soil through tilling:

- surface resistance for all soil textures 758 kPa
- subsurface resistance for sandy soil textures 1793 kPa
- subsurface resistance for silty soil textures 1793 kPa
- subsurface resistance for silty soil textures 1551 kPa

Compact growing medium under the root balls of all trees to between 200,000 and 250,000 kg/m² when the soil is between 12 and 20 per cent moisture to reduce settlement and provide a stable base for the tree as indicated on the drawings. Take care not to over-compact growing medium during and following the installation process.

At the end of the installation of the growing medium and prior to the installation of additional organic matter and plants, take a minimum of four undisturbed samples from locations selected by the Contract Administrator to determine bulk density. Submit test results for approval.

Confirm that infiltration rate of installed growing medium is 50 to 75 mm/hr.

TS 5.10.07.07 Protection

Protect growing medium from compaction and contamination by dust, debris, and any toxic material harmful to plants or humans after installation. Any area, which becomes compacted, shall be tilled to a depth of 150 mm. Any uneven or settled areas shall be filled and re graded.

Phase the installation of the growing medium such that equipment does not travel over already installed growing medium.

Cover installed growing medium with plywood until construction activity is complete and ready to plant.

Keep newly installed growing medium off-line from irrigation and drainage until planted.

TS 5.10.07.08 Growing Medium Fine Grading

The Contractor Administrator shall view all rough grading prior to the installation of organic matter, fine grading, planting, and mulching.

Set grades at time of installation sufficiently high relative to the type of growing medium and the typical settlement so that the growing medium will be at the correct grade after the 12 month settlement period.

This specification assumes that initial settlement during the first 12 months after installation will be between 10 and 15 per cent of the installed depth. Assure that the grading is mounded sufficiently high to accommodate this settlement.

At the end of the Contract Warrantee Period, if grades have settled more than 5 per cent below the grades as specified in the Contract drawings, reset the grades to the final grades shown on the Grading Plan, taking the observed settlement into account. Carefully remove and protect the plant material before executing any grading. Additional growing medium shall not be placed on planted soil until plants are carefully removed. The additional depth of growing medium can impede oxygen exchange and suffocate the plants.

Adjust the finish grades to meet field conditions.

Provide for positive drainage from all areas toward the existing inlets, drainage structures and or the edges of planting beds. Adjust grades as directed to reflect actual constructed field conditions of paving, wall and inlet elevations. Notify the Contract Administrator of difficulty achieving positive drainage.

Provide smooth transitions between slopes of different gradients and direction. Modify the grade so that the finish grade is flush with all paving surfaces or as directed by the Contract drawings.

Fill all dips and remove any bumps in the overall plane of the slope.

The tolerance for dips and bumps in shrub and ground cover planting areas shall be a 25 mm deviation from the plane in 2000 mm.

Restore all grades after the installation of plants. Remove any excess soil removed during the planting process.

TS 5.10.07.09 Installation of Yard Waste Compost

In all areas of growing medium in open planting beds, after the specified growing medium is installed, and just prior to the installation of tree, shrub or groundcover plantings, spread 100 mm of yard waste compost and till into the top 150 mm of the growing medium. Restore grades after tilling.

TS 5.10.07.10 Clean-up

During installation, keep pavements clean and work area in an orderly condition.

Keep the site clear of trash and debris at all times. Immediately dispose of wrappings or waste materials associated with products necessary for the completion of the work.

All trash and debris shall be kept in a central collection container. Do not bury trash and debris in back-fill.

Once installation is complete, remove any excess soil from pavements or embedded fixtures.

TS 5.10.07.11 Protection during Construction

The Contractor shall protect work and materials from damage including: compaction, contamination, and erosion due to operations by other contractors or trespassers. Maintain protection during installation until acceptance. Treat, repair or replace damaged growing medium installation work immediately.

Till compacted growing medium and replace growing medium that has become contaminated as determined by the Contract Administrator. Growing medium shall be tilled or replaced by the Contractor at no extra cost the City.

TS 5.10.07.12 Repair of Settled Growing Medium

At the end of 12 months following the date of substantial completion of the growing medium installation work, inspect the site and restore any areas where the grades have settled beyond the elevations shown on the drawings by an amount greater than 25 mm.

Settlement of trees below the finished grades shown on the Contract drawings will not be accepted. Where settlement of trees and tree planting areas has occurred, carefully remove and protect the tree and root ball, add the specified growing medium to the final grades shown on the Grading Plan, taking the observed settlement into account, re-plant and re-mulch. Growing medium shall not be placed over a tree's zone of active taper. If the tree was planted too high, that is to say settlement did not proceed as expected over the 12 month settlement period, then the tree must be carefully removed and protected while the grades are re-set.

In shrub planting areas where the settlement is less than 5 per cent below the grades shown on the Contract drawings, remove the mulch, top dress the area with the specified growing medium and re-mulch. All ground cover areas and shrub planting areas where the settlement is greater than 5 per cent below the grades shown on the Contract Drawings, remove the mulch and plants, add the specified growing medium to the final grades shown on the Grading Plan, taking the observed settlement into account, re-plant and re-mulch.

TS 5.10.07.13 Aeration of In-situ Growing Medium around Existing Trees

For instances where compaction of in-situ site soils within the Tree Protection Zone (TPZ) of existing trees exceeds the range specified in TS 5.10.07.06, remediation shall be undertaken to aerate or physically alter soils to provide a more suitable growing condition.

An arborist currently registered with ISA or qualified professional approved by Urban Forestry shall be engaged to determine the most appropriate procedure.

- Core aeration: Pore space in compacted soil may be increased by removing small soil cores to a depth of about 75 mm. This is effective in increasing surface permeability but does not address compaction in deeper soil layers.
- Vertical mulching: Holes 25-50 mm in diameter may be drilled in the compacted soil and filled with perlite, vermiculite, or other amendment material.
- Radial trenching: Trenches 150-200 mm wide and no deeper than the root system or depth of compaction can be dug with trenching equipment. The trenches are dug around the trunk of an existing tree in a bicycle spoke pattern, extending from the trunk and backfilled with a mixture of soil and amendments.
- Air excavation: Alternating pie-shaped wedges of soil around an existing tree can be de-compacted by "tilling" compost into surface soil around roots with an air excavation tool. Air excavation can damage roots if high pressure is used, so soil should be de-compacted in no more than 50 per cent of the root system at a time.

TS 5.10.08 QUALITY ASSURANCE – Not Used

TS 5.10.09 MEASUREMENT FOR PAYMENT

TS 5.10.09.01 Existing Site Soil Mix

Measurement of existing site soil mix shall be measured by volume in cubic metres (m³).

TS 5.10.09.02**Type 1 – Standard Mix****Type 1 – Standard Mix, 100 mm Thick****Type 1 – Standard Mix, 200 mm Thick****Type 1 – Standard Mix, 300 mm Thick**

Measurement of standard mix growing medium shall be measured by area in square metres (m²).

TS 5.10.09.03**Type 2 – Planting Bed Mix****Type 2 – Planting Bed Mix, 100 mm Thick****Type 2 – Planting Bed Mix, 200 mm Thick****Type 2 – Planting Bed Mix, 300 mm Thick**

Measurement of planting bed growing medium shall be measured by area in square metres (m²).

TS 5.10.09.04**Type 3 – Boulevard Mix****Type 3 – Boulevard Mix, 100 mm Thick****Type 3 – Boulevard Mix, 200 mm Thick****Type 3 – Boulevard Mix, 300 mm Thick**

Measurement of boulevard mix growing medium shall be measured by area in square metres (m²).

TS 5.10.09.05**Type 4 – Bioretention Mix****Type 4 – Bioretention Mix, 300 mm Thick****Type 4 – Bioretention Mix, 600 mm Thick****Type 4 – Bioretention Mix, 1000 mm Thick**

Measurement of boulevard mix growing medium shall be measured by area in square metres (m²).

TS 5.10.10**BASIS OF PAYMENT****Existing Site Soil Mix – Item****Type 1 – Standard Mix, 100 mm Thick – Item****Type 1 – Standard Mix, 200 mm Thick – Item****Type 1 – Standard Mix, 300 mm Thick – Item****Type 2 – Planting Bed Mix, 100 mm Thick – Item****Type 2 – Planting Bed Mix, 200 mm Thick – Item****Type 2 – Planting Bed Mix, 300 mm Thick – Item****Type 3 – Boulevard Mix, 100 mm Thick – Item****Type 3 – Boulevard Mix, 200 mm Thick – Item****Type 3 – Boulevard Mix, 300 mm Thick – Item****Type 4 – Bioretention Mix, 300 mm Thick – Item****Type 4 – Bioretention Mix, 600 mm Thick – Item****Type 4 – Bioretention Mix, 1000 mm Thick – Item**

Payment at the Contract Price for the above tender item shall be full compensation for all labour, Equipment and Material to do the work.

Form 1: Contractors submittal checklist

✓	Section #	Item
Certificates		
	TS 5.10.04.01.02	Certification that all growing medium components and the growing medium meet all environmental standards
Product Data		
	TS 5.10.04.01.03	<i>Product data: Coarse sand</i>
	TS 5.10.04.01.03	Product data: Pine bark compost
	TS 5.10.04.01.03	Product data: Yard waste compost
Material Source Locations		
	TS 5.10.04.01.04	Location of all topsoil and growing medium components sources
Samples		
	TS 5.10.04.01.05	Duplicate 4L samples: Topsoil / submitted with required testing results
	TS 5.10.04.01.05	Duplicate 1L samples: Coarse sand / submitted with required testing results
	TS 5.10.04.01.05	Duplicate 1L samples: Pine bark compost / submitted with required testing results
	TS 5.10.04.01.05	Duplicate 1L samples: Yard waste compost / submitted with required testing results
	TS 5.10.04.01.05	Duplicate 4L samples: Growing medium / submitted with required testing results
Testing Reports		
	TS 5.10.04.01.06	Particle size analysis: Topsoil including sand fractions
	TS 5.10.04.01.06	Particle size analysis: Growing medium including sand fractions
	TS 5.10.04.01.06	Chemical analysis: Topsoil
	TS 5.10.04.01.06	Chemical analysis: Growing medium with lab recommendations for fertilizer applications and amendments.
	TS 5.10.04.01.07	In-Situ Compaction Testing: Installed growing medium
	TS 5.10.04.01.06	Infiltration Rate Testing: Installed growing medium
Contractor's Qualifications		
	TS 5.10.04.01.08	Documentation of contractor's qualifications

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Planting****Table of Contents**

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TS 5.30.01 SCOPE

This specification covers the requirements for the supply and installation of trees, shrubs, and perennials, groundcovers, ornamental grasses and the regular maintenance of plant material within the contract limits.

TS 5.30.02 REFERENCES

This specification refers to the following standards, specifications or publications:

City of Toronto Specifications

TS 5.10 Construction Specification for Growing Medium

City of Toronto Standard Drawings

T-850.026 Planting Details and Sample Layouts

Canadian Nursery Landscape Association

CNLA Canadian Standards for Nursery Stock

Agriculture Canada

Plant Hardiness Zone Map – Zone 5

Society for Ecological Restoration – Ontario Chapter

Native Plants Buyers Guidelines

TS 5.30.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Certified Arborist means they are designated and regulated by the International Society of Arboriculture (ISA).

Pruning means pruning is the horticultural or arboricultural practice involving the selective removal of certain parts of a plant, such as branches, buds, or roots.

TS 5.30.04 DESIGN AND SUBMISSION REQUIREMENTS

TS 5.30.04.01 Plant Material

Make arrangements for approval of plant material by the Contract Administrator at a time mutually agreed upon according to TS 5.30.07.01 herein. No work shall proceed without approval of the Contract Administrator.

Prior approval shall not invalidate rejection of stock at later inspection at site should it, in the Contract Administrator's opinion, prove defective, damaged or generally inappropriate.

All plants shall be according to the varieties specified in the plant list and be legibly tagged with their proper name and size. No substitutions will be accepted without written approval of the Contract Administrator

Prior to installation, the Contractor shall advise the Contract Administrator in writing if in the Contractor's opinion any of the specified plant material will not perform according to the specifications. The City retains the right to direct the Contractor to proceed with the specified plant material including guarantee and as tendered.

Planting soil mix requirements shall be according to TS 5.10 and Type 4 – Bio Retention Mix, and Contract Documents.

Imported plant material shall be accompanied with the necessary permits and import licenses. Contractor is to conform to all federal and provincial regulations.

Tagged material to be purchased and secured for project.

Any additional expenses for re-sourcing and approval of plant material shall be at no extra cost to the City.

All plant material industry suppliers shall be considered for material supply, not only those having pre-existing or current supply accounts with the landscape contractor.

If plant material is undersized, plant quantities will increase according to the following schedule:

- (1) perennial / groundcover / ornamental grass 9 cm pot = (3) perennial / groundcover / ornamental grass plug (PL50)
- (1) 1 gal container perennial/groundcover = (3) perennial/groundcover 9 cm pots
- (1) 5 gal container shrub = (2) 3 gal container shrubs
- (1) 3 gal container shrub = (2) 2 gal container shrubs
- (1) 2 gal container shrub = (3) 1 gal container shrubs / grasses

Undersize nursery stock for trees will not be accepted.

TS 5.30.04.02 Submittals

Submit affidavits to certify that manufactured or processed materials supplied in bulk meet specified requirements.

Submit instructions on maintenance procedures to be followed after end of specified maintenance period.

Prior to planting, submit the following to be approved by the Contract Administrator and Urban Forestry:

- 1) Plant list including the source, scientific and common name, quantity, caliper, root ball size and root ball packaging specification for each plant
- 2) Plant schedule including dates scheduled for tagging, field digging, delivery and planting
- 3) Certification of plant quality from growing nursery confirming that plants tagged, field dug and shipped meet all requirements of the Canadian Nursery Stock Standard, 9th Edition
- 4) Maintenance plan and schedule for maintenance during warranty period.

Prior to completion of the warranty period, submit the following to be approved by the Contract Administrator and Urban Forestry:

- 1) Maintenance log indicating the date and duration of every maintenance activity completed.
- 2) Plans for any maintenance activity that differ from the submitted maintenance plan and schedule, such as Integrated Pest Management (IPM), fertilizing or soil remediation, prior to undertaking such activities.
- 3) Plant list, plant schedule and certification of plant quality prior to any replacement planting.

TS 5.30.04.03 Product Delivery, Storage and Handling

All materials shall be inspected by the Contractor for damage in transit. No defective material shall be delivered to the site. Material subsequently damaged shall be removed from the site immediately.

Label manufactured, processed or otherwise prepared materials that are packaged to indicate manufacturer, contents, weight, and a detailed description of the material. If delivered in bulk, submit affidavits giving information required as specified for labels and certifying that materials meet specified requirements. Store and protect fertilizer, limestone, bone meal, mulching materials, and similar products to prevent damage from moisture.

No plant shall be accepted when the ball of earth surrounding its root system has been cracked or broken prior to or during planting, or after the burlap, staves, ropes or platform required in transplanting have been removed.

Trees specified as W.B.—wire basket—shall have solid root balls wrapped with 140 gram burlap with no preservatives added. Root balls to have double thickness and be drum laced with 15 mm twine at 200 mm spacing.

Shrubs specified as B & B—ball & burlap—shall have solid root balls wrapped with 140 gram burlap with no preservatives added. Root balls under 460 mm diameter to have single thickness, and between 460 and 900 mm diameter size to have double thickness and be drum laced with 15 mm twine at 200 mm spacing.

Transport plants with branches tied to prevent damage, and padded to avoid abrasion from equipment. Protective materials and burlap wrap tied around base of tree trunk are to be removed from the tree prior to planting.

Trees are to be handled securely and with care to protect the bark and branches from mechanical damage. Trees must not be handled by the trunk.

Prevent drying out of roots, root balls, trunks, branches, and leaves of plants from time of removal at place of origin until they are planted. While temporarily stored at site, protect them with soil, or similar materials and keep moist. If stored for more than one hour between delivery and planting, store in a shaded location approved by the Contract Administrator, cover with soil or mulch, and keep root balls moist through frequent watering until trees are planted.

TS 5.30.04.04 Job Conditions

Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

Installation shall be done under suitable weather conditions and in a suitable growth season for each specified material, as noted below:

Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of acceptance.

- 1) Spring Planting: May–June.
- 2) Fall Planting: September–November.

Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements. Suspend work when the temperature is below 4°C, the wind velocity is over 32 km/hr, the ground or planting soil is frozen or wet, or the continuation of prevailing weather will damage plant materials, including sustained periods of above-normal high temperatures and precipitation.

TS 5.30.05 MATERIALS

TS 5.30.05.01 Plant Material

Type of root preparation, sizing, grading and quality shall be according to the Canadian Standards for Nursery Stock.

Source of plant material shall be grown in Zone 5 according to Agriculture Canada Plant Hardiness Zone Map. Native plants to be sourced from nurseries within 100 km of Toronto, unless otherwise approved by the City.

Plant material shall be freshly dug—at a time of year that is horticulturally acceptable for the species—free of disease, die-back, insects, defects or injuries and structurally sound with strong fibrous root system and densely foliated, root pruned regularly, but not later than one growing season prior to arrival on site.

Trees shall be with straight trunks, well and characteristically branched for species. Container grown trees shall not be permitted for planting, unless approved by the Contract Administrator prior to purchase. Contractor to advise nurseries that trunk flare must be exposed above root ball before arrival on site. Trees that fail to meet this requirement shall be rejected by the Contract Administrator. Where the Contract Administrator approves the removal of any excess soil on top of the root ball shall be at no extra cost to the City and the 2-year warranty remains.

- 1) Provide healthy stock, grown in a nursery and free of die-back, disease, insects, eggs, bores, and larvae. At the time of planting all plants shall have a root system, stem, and branch form that will not restrict normal growth, stability and health for the expected life of the plant.

-
- 2) Plants shall be healthy with the color, shape, size and distribution of trunk, stems, branches, buds and leaves normal to the plant type specified.
 - 3) The form and density of the crown shall be typical for a young specimen of the species or cultivar pruned to a central and dominant leader.
 - 4) The size, color, and appearance of leaves shall be typical for the time of year and stage of growth of the species or cultivar. Plants shall not show signs of prolonged moisture stress or over watering as indicated by wilted, shriveled, or dead leaves.
 - 5) Shoot growth – length and diameter – throughout the crown should be appropriate for the age and size of the species or cultivar. Plants shall not have dead, diseased, broken, distorted, or otherwise injured branches.
 - 6) Main branches shall be distributed along the central leader not clustered together. They shall form a balanced crown appropriate for the cultivar/species.
 - 7) Branch diameter shall be no larger than two-thirds (one-half is preferred) the diameter of the central leader measured 25 mm above the branch union.
 - 8) The attachment of the largest branches – scaffold branches – shall be free of included bark.
 - 9) Tree trunks shall be relatively straight, vertical, and free of wounds that penetrate to the wood (properly made pruning cuts, closed or not, are acceptable and are not considered wounds), sunburned areas, conks – fungal fruiting bodies, wood cracks, sap leakage, signs of boring insects, galls, cankers, girdling ties, or lesions – mechanical injury.
 - 10) All graft unions, where applicable, shall be completely closed without visible sign of graft rejection. All grafts shall be visible above the soil line.
 - 11) Roots shall be free of scrapes, broken or split wood.
 - 12) The root system shall be free of injury from biotic (e.g., insects and pathogens) and abiotic (e.g., herbicide toxicity and salt injury) agents.
 - 13) A minimum of three structural roots reasonably distributed around the trunk – not clustered on one side – shall be found in each plant. Root distribution shall be uniform throughout the root ball, and growth shall be appropriate for the species.
 - 14) The root collar shall be within the upper 50 mm of the substrate/soil. Two structural roots shall reach the side of the root ball near the top surface of the root ball.
 - 15) The root system shall be free of stem girdling roots over the root collar or kinked roots from nursery production practices

Measure plants with branches in normal position, finish grade to top of main body of plant, not from branch tip to branch tip or from root base to branch tip. Caliper dimension shall refer to diameter of trunk measured 300 mm above ground in original growing state.

Plants larger than specified shall be accepted without liability to extra charges if approved by the Contract Administrator, and they meet all specified requirements for their size.

Collected plants, those dug from native stands, wood lots, orchards or neglected nurseries, and having received no cultural maintenance, will not be accepted.

Plant varieties are specified in a plant schedule on the plan, and all substitutions must be approved by the Contract Administrator prior to ordering plant material. In case of discrepancy in quantity between the plant schedule or unit price schedule, the plan shall take precedence.

TS 5.30.05.02 Planting Soil

Planting soil shall be according to TS 5.10.

TS 5.30.05.03 Water

Potable water shall be used unless the Contractor provides testing results that demonstrate the water to be used is free of contaminants or impurities that would adversely affect the germination and growth of vegetation.

TS 5.30.05.04 Tree Guards

Suppliers shall install an Arbor Guard™ tree guard, or pre-approved equivalent, around each newly planted tree. If required, use more than one guard to ensure that the entire base of the tree is protected. The cost of installation shall be included in the unit price of the tree. Proof of purchase will be required. The Supplier shall replace or reinstall defective guards for the duration of the warranty period. Tree guards shall remain onsite at the end of the warranty period.

TS 5.30.05.05 Root Barrier

Root barrier—root diversion device—shall be a geo-composite membrane to prevent root penetration under hard boulevard surfaces. The material shall be impermeable and ribbed with a thickness of 1 – 2 mm. Provide sample and proof of source to the Contract Administrator for approval prior to delivery and installation.

TS 5.30.05.06 Mulch

Planting beds shall be a blend of aged bark and compost materials. Provide sample and proof of source to the Contract Administrator for approval prior to delivery and installation. For compost requirements, see TS 5.10.

Tree planting openings or planting beds in hard boulevard surface areas shall be a hardwood blend or finely shredded pine bark mulch pre-blended with an erosion control organic tacifier. Provide sample and proof of source to the Contract Administrator for approval prior to delivery and installation. For compost requirements, see TS 5.10.

A low growing sedum mat or similar low growing, low maintenance groundcover option. Provide sample and proof of source to the Contract Administrator for approval prior to delivery and installation.

For mulch requirements in bioretention areas, see TS 5.10.

TS 5.30.05.07 Soil Amendments

Soil amendments shall refer to soil test report recommendations, according to TS 5.10.

TS 5.30.05.08 Anti-desiccant

Anti-desiccant shall be an emulsion to form permeable film over plant surfaces and mixed according to manufacturer's directions.

TS 5.30.06 EQUIPMENT – Not Used**TS 5.30.07 CONSTRUCTION****TS 5.30.07.01 Pre-planting Operations**

All plant material shall be acceptable to the Contract Administrator. Contractor shall:

- 1) Arrange for nursery approval of trees. Contractor to source trees upon Contract award, as trees are a long lead item.
- 2) Contractor to provide a schedule of suppliers for plant stock showing supplier, species and size, as well as a purchase order showing purchase arrangements.
- 3) All trees must be planted according to the Contract Drawings, approved by Urban Forestry, and must arrive on site in balled and burlapped condition with a minimum caliper of 70 mm or as specified in Contract Drawings.

Unwrap and cut away top one half of jute wrapping and wire basket without damaging root ball. Do not pull burlap or rope from under root ball.

Each tree shall have the burlap and wire cage opened and soil brushed away until the first proper root is found, indicating the top of the root ball. In planting instructions for the tree, this level will be considered the top of root-ball.

- 4) Arrange for approval sample of each shrub type on site, prior to general order and delivery.

Properly prune damaged roots and branches from plant material prior to planting.

Ensure that subgrade preparation and drainage is satisfactory for plant material growth.

Drain test shall ensure adequate subsoil drainage by filling bottom one-third of tree pit with water and checking for complete drainage after 24 hours. Obtain approval of drain test from the Contract Administrator prior to planting and backfilling.

TS 5.30.07.02 Excavation and Preparation of Planting Beds

Preparation of planting beds shall be according to TS 5.10 and as specified in the Contract Documents.

For individual planting holes:

-
- 1) Stake out location and obtain approval from the City prior to excavating.
 - 2) Excavate to depth and width as specified in the Contract Documents
 - 3) Scarify sides and break up soil at bottom of planting hole to a depth of 200 mm, or as specified in the Contract Documents.
 - 4) Remove water which enters excavations prior to planting. Notify the Contract Administrator if water source is ground water.

For requirements for using existing topsoil/growing medium for planting, see TS 5.10.

Mix topsoil/growing medium and amendments just before planting, but not when frozen or muddy. Do not stockpile more than two days.

Excavate plant pits to allow at least 150 mm of planting soil under root ball, or as specified in the Contract Drawings.

When planting in late fall or early spring, prevent freezing of bottom of plant pits.

Provide further excavation and additional planting soil to ensure adequate drainage for survival of the plants.

Install root barrier to the full depth of the planting area, and as shown on the Contract Drawings.

Placing of growing medium shall be according to TS 5.10.

Fertilizer shall be applied during the final operation of fine grading, but not longer than one week prior to planting, as per the recommendations in the soil analysis report.

TS 5.30.07.03 Planting

Final placement of shrubs shall be approved by the Contract Administrator prior to backfilling with growing medium.

Final placement of trees shall be approved by the Contract Administrator prior to excavation for tree planting.

Any tree found planted with the first proper root more than 2.5 cm below planting level will be rejected and require replacement or replanting.

For container stock or root balls in non-biodegradable wrapping, remove entire container or wrapping without damaging root ball prior to planting.

Plant material to be planted vertically in locations as indicated.

Trees to be oriented with southern exposure as marked by the nursery, or as directed by the Contract Administrator to give best appearance on site.

Trees to be planted at a level that places trunk flare above finished grade, and as specified in the Contract Drawings.

For trees and shrubs:

- 1) Backfill growing medium in 150 mm lifts. Tamp each lift to eliminate air pockets. When two thirds of depth of planting pit has been backfilled, fill remaining space with water. After water has penetrated into soil, backfill to finish grade.
- 2) Form watering saucer as indicated on details.

Planting details shall be according to T-850.026.

Water plant material thoroughly. After soil settlement has occurred, fill with soil to finish grade. Dispose of burlap, wire and container material off site.

TS 5.30.07.04 Mulching Planting Beds

Ensure soil settlement has been corrected prior to mulching.

Provide continuous layer of mulch for all shrub beds.

Ensure ground is not frozen prior to mulching.

TS 5.30.07.05 Pruning

Any tree pruning must be undertaken by a certified arborist. Prior to pruning, submit the name and credentials of the certified arborist to the Contract Administrator and a copy furnished to urban Forestry.

Shrubs shall be pruned according to proper arboricultural practices. Make pruning cuts smooth and clean just outside the branch collar. Leave no stubs. Cut back cambium to living tissue where cuts are made at bruises, scars and other injuries. Ensure that pruning cuts are shaped to prevent the retention of water.

TS 5.30.07.06 Maintenance During Establishment Period

Perform the following maintenance operations from time of planting:

- 1) Water to maintain soil moisture conditions for optimum establishment, growth and health of plant material without causing erosion.
- 2) For evergreen plant material, water thoroughly in late fall prior to freeze-up to saturate soil around root system.
- 3) Remove weeds monthly.
- 4) Replace or re-spread damaged, missing or disturbed mulch.
- 5) Where mulch is in place, remove and replace in spring after soil thaws and warms up. Top up as necessary to maintain a 25–50 mm layer depth.
- 6) Apply pesticides according to federal, provincial and municipal regulations as and when required to control insects, fungus and disease. Obtain written product approval from Urban Forestry prior to application.

-
- 7) Remove dead or broken branches from shrubs and herbaceous material, according to proper horticultural practice.
 - 8) Remove dead or broken branches from trees according to proper arboricultural practice. Any such pruning is to be performed by a certified arborist.
 - 9) Keep trunk protection in proper repair and adjustment.
 - 10) Remove and replace dead plants and plants not in healthy growing condition. Make replacements in same manner as specified for original plantings.

TS 5.30.07.07 Acceptance, Adjustment and Replacement

At time of Final Acceptance and again at termination of Warranty Period, Work shall be inspected by the Contract Administrator and adjustments and replacements shall be made according to the following:

- 1) Commencement of Warranty Period is predicated on written acceptance by the Contract Administrator.
- 2) Adjustment and replacement work shall be performed with materials of same size, variety and quality of material replaced.
- 3) Replacement work shall be done under an additional Warranty Period of the same length and conditions as described in this specification. It shall date from time of the Contract Administrator's approval of replacement work.
- 4) Replace plant stock that in the opinion of the Contract Administrator is dead, or not in satisfactory growing state, or does not meet specification requirements. Remove dead stock immediately. Replace stock at proper time during planting season. At the discretion of the Contract Administrator, unacceptable plant material may be left, its guarantee period extended, and again inspected next planting season. At this time, the Contract Administrator will decide if replacement will be made and the guarantee extended accordingly.
- 5) For repair of settled growing medium, see TS 5.10.

TS 5.30.07.08 Regular Maintenance During Warranty Period

Work shall include maintenance of installations to ensure both satisfactory aesthetic upkeep and a vigorous and healthy growth until the end of the Warranty Period.

For plant material and planting areas such as planters, tree planting areas and beds: pruning; cultivating; hand weeding; mulching; litter and debris removal, resetting to proper grade or to upright positions; spraying to keep free from pests, insects and disease; and barriers to prevent damage by persons or animals.

Inspect protective tree surrounds such as tree fences, tree grates, planter curbs and tree guards for damage or graffiti, and for any discontinuity between planting sites and walking surfaces that could create tripping risks. Repair immediately or secure site until repairs can be made, notify Contract Administrator and record repairs in maintenance log.

Litter removal shall take place every two weeks. Weeds shall not exceed 150 mm in height. Annual spring and fall clean-ups shall be completed, including seasonal pruning and cutting back of vegetation, removal of dead or excess foliage and debris, and general preparation of beds for the upcoming season.

All plant material installed under this section is to be watered for the duration of the Warranty Period to ensure healthy, vigorous plant growth at all times. Watering is to be coordinated in order to prevent over and/or under watering. Contractor is responsible for ensuring adequate watering of plant material during Warranty Period.

Water tree and shrub beds to ensure saturation of full depth of planting soil. Care must be taken to avoid over-watering in the event of slow draining subsoil conditions.

Top up mulch as necessary to maintain a 25–50 mm minimum layer depth.

TS 5.30.08 QUALITY ASSURANCE

TS 5.30.08.01 Warranty

All plants shall be guaranteed for a period of two years following written acceptance in accordance with the General Conditions of the Contract and as modified by this section, and shall be alive and in vigorous growth at the end of the Warranty Period.

Less than 30 Days prior to frost or after October 15, whichever comes first, the start of warranty does not start until the following spring, 30 Days after start of growing season.

All plant material that in the opinion of the Contract Administrator is not in a healthy growing condition shall be replaced by the Contractor at no extra cost to the City, prior to terminating their responsibilities under this Contract.

All plant material that in the opinion of the Contract Administrator has not survived the first winter—based on a site inspection by the Contract Administrator in early spring—shall be replaced by the Contractor within two weeks of notification by the Contract Administrator.

Seasonal timing of all other replacement plantings shall be at the discretion of the Contract Administrator, based on an evaluation of the original planting and replacement planting conditions.

All replacements shall be plants of the same size and variety as specified in the Contract Documents. The cost shall be borne by the Contractor, except for possible replacement resulting from theft, vandalism, or carelessness on the part of others. The Contract Administrator shall be the sole judge in case of dispute regarding responsibility for replacement of plant material.

TS 5.30.09 MEASUREMENT FOR PAYMENT

TS 5.30.09.01 Perennial, Ground Cover, Ornamental Grass, 9 cm Pot

For measurement purposes, a count shall be made of the number of 9 cm pot(s) installed.

TS 5.30.09.02 Perennial and Ground Cover, 1 Gallon

For measurement purposes, a count shall be made of the number of one-gallon containers(s) installed.

TS 5.30.09.03 Shrub, 5 Gallon

For measurement purposes, a count shall be made of the number of 5-gallon containers(s) installed.

TS 5.30.09.04 Shrub, 3 Gallon

For measurement purposes, a count shall be made of the number of 3-gallon containers(s) installed.

TS 5.30.09.05 Shrub, 2 Gallon

For measurement purposes, a count shall be made of the number of 2-gallon containers(s) installed.

TS 5.30.09.06 Tree, 70 mm Caliper

For measurement purposes, a count shall be made of the number of 70 mm caliper tree(s) installed.

TS 5.30.09.07 Mulch

Measurement of mulch shall be measured by area in square metres (m²).

TS 5.30.10 BASIS OF PAYMENT

TS 5.30.10.01 Perennial, Ground Cover, Ornamental Grass, 9 cm Pot – Item
Perennial and Ground Cover, 1 Gallon – Item
Shrub, 5 Gallon – Item
Shrub, 3 Gallon – Item
Shrub, 2 Gallon – Item
Tree, 70 mm Caliper – Item

Payment at the Contract Price for the above tender items shall be full compensation for all labour, Equipment and Material to do the Work.

appendix C
**TREE PROTECTION
POLICY AND
SPECIFICATIONS FOR
CONSTRUCTION NEAR
TREES**

Toronto Parks, Forestry and Recreation
Urban Forestry
July 2016

Tree Protection Policy and Specifications for Construction Near Trees

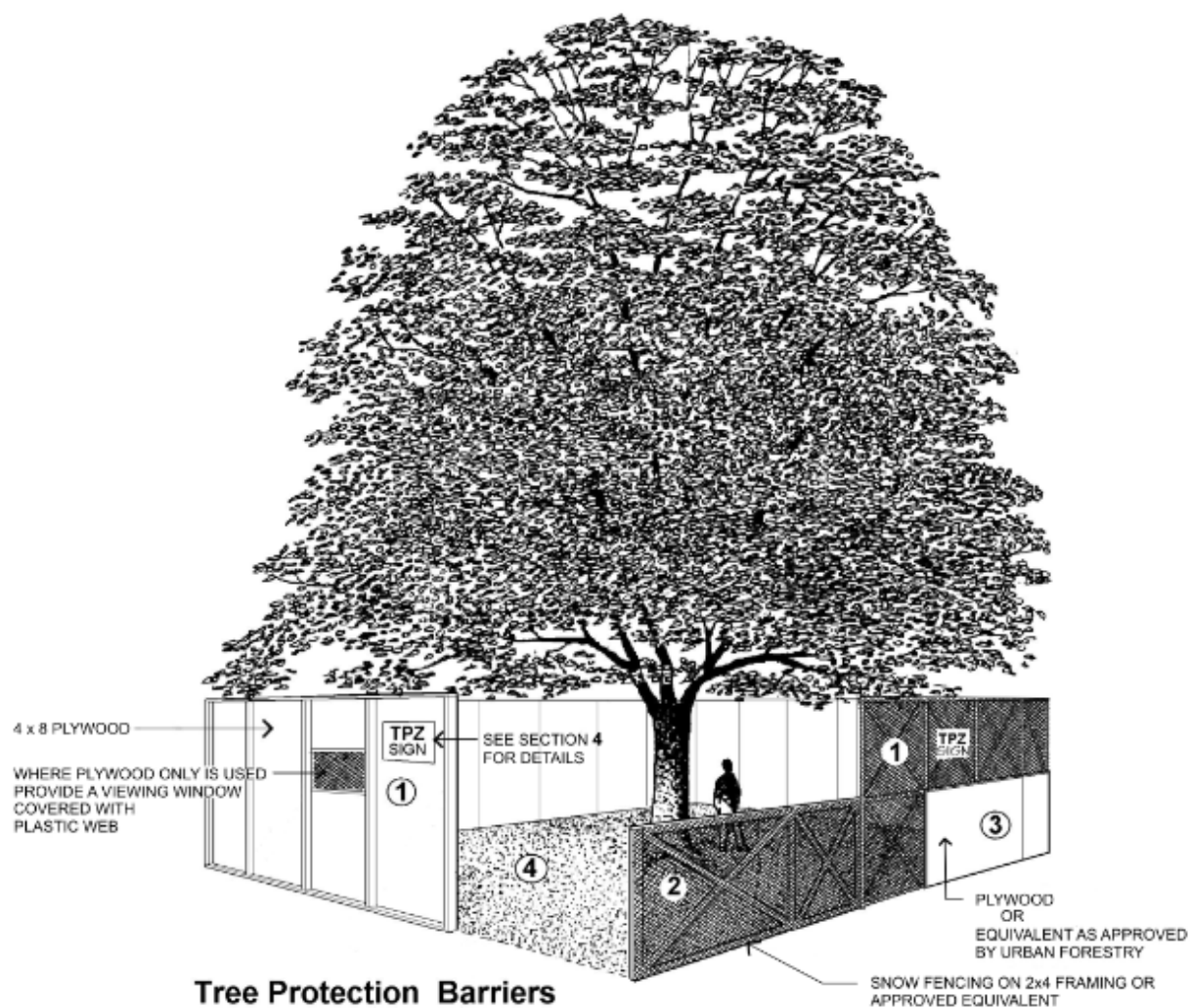


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1. Introduction

Maintenance, growth and enhancement of the urban forest are important goals of the City of Toronto. Preserving and protecting healthy trees can help the City to achieve these goals. Considering tree protection in the initial stages of construction planning may mean the difference between preserving a healthy tree and having to remove it. Plans created with tree protection in mind help protect the city's urban forest.

The tree protection policy and specifications outlined below reflect the policy of Toronto City Council. Anyone failing to adhere to the tree protection policy and specifications will be financially responsible for any resulting damage to trees and may be charged under the provisions of the applicable City of Toronto tree by-law or subject to orders to comply.

Prior to commencing with any demolition or construction activity it is important that an arborist¹ determines the location, species, size and condition of trees on the property and surrounding properties and becomes familiar with the tree protection by-laws that could impact the proposal.

The following by-laws protect trees in the City of Toronto:

- [Street Tree By-law](#), City of Toronto Municipal Code Chapter 813, Article II, protects all trees situated on City streets.
- [Private Tree By-law](#), Article III, Chapter 813 of the City of Toronto Municipal Code protects trees on private property with diameter of 30cm or more and trees of any diameter that were planted as a condition of a permit issued under this bylaw or a site plan agreement.
- The [Ravine & Natural Feature Protection By-law](#), Chapter 658 of the City of Toronto Municipal Code prohibits and regulates the injury and destruction of trees, as well as filling, grading and dumping within designated areas of the City. There is no minimum diameter for a tree to qualify for protection under the Ravine and Natural Feature Protection By-law. Trees of any size located in the designated areas qualify for protection.
- The [Parks By-law](#), Municipal Code Chapter 608, Article VII protects all trees located in a City park.

All above noted by-laws are implemented by Urban Forestry under the authority of the General Manager, Parks, Forestry and Recreation. City of Toronto's tree protection by-laws can be found at www.toronto.ca/trees.

Types of Tree Damage

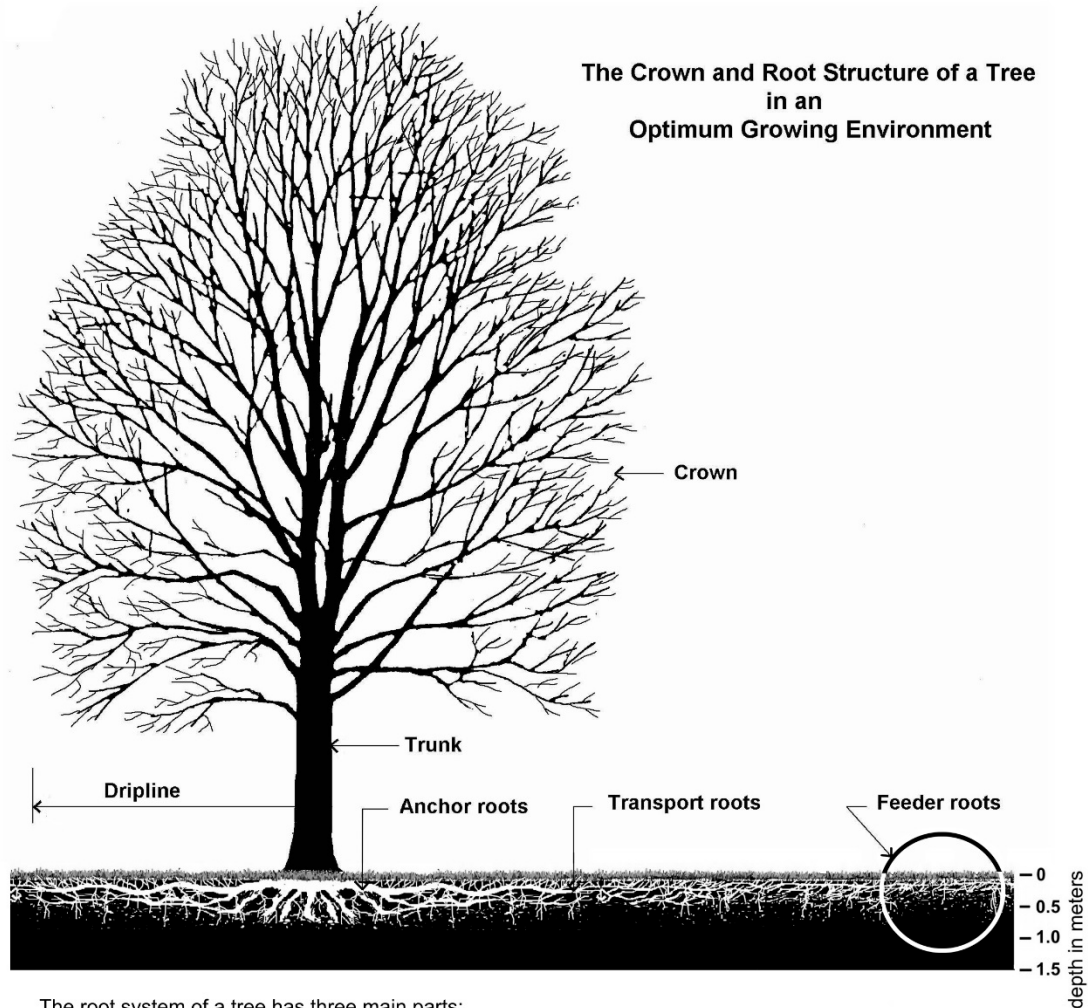
Physical injury to the trunk, crown and roots of a tree will occur if construction equipment is permitted close to trees or if structures are built into the growing space of a tree. Inappropriate pruning may also result in tree injury. Physical injuries are permanent and can be fatal.

¹ Arborist – An expert in the care and maintenance of trees including an arborist qualified by the Ontario Training and Adjustment Board Apprenticeship and Client Services Branch, a certified arborist qualified by the International Society of Arboriculture, a consulting arborist registered with the American Society of Consulting Arborists, a registered professional forester or a person with other similar qualifications as approved by the General Manager, Parks, Forestry and Recreation.

Root cutting is another type of physical injury that can significantly impact the health of a tree. The majority of tree roots are found in the upper 30 to 60 cm of soil. Excavation for foundations or utility installation may cut roots if the excavation is too close to trees. Trees can become destabilized and may fall over if anchor roots are severed.

Compaction of the soil in the tree root zone is one of the leading causes of tree decline in Toronto's urban forest. Soil compaction occurs primarily from vehicles and equipment moving across the root zones. Piling or storing materials or debris on top of the root system can also result in soil compaction. Soil compaction causes the pore spaces in the soil, which contains air and water necessary for root growth, to be reduced. Without space available for oxygen and water, tree roots will suffocate and tree decline will follow. With rutting, a form of intense compaction, roots are severed by the tires of equipment. Root destruction can also be caused by changes to the existing grade. Adding soil on top of tree roots can smother them by reducing the amount of oxygen and water they can receive. Only a few centimetres of added soil can have a detrimental impact on tree health.

The structural elements of a tree in an optimal growing environment are shown on Figure 1. This figure illustrates the terms used in this policy.



The root system of a tree has three main parts:
Forming the base of the tree are large **anchor roots** from which extend long **transport roots** which together provide the main structural framework for trees. From the transport roots extend a complex network of **feeder roots** that grow outward and upward. These non-woody roots branch out to form fans of thousands of slender roots with fine root hairs. These tiny roots provide the surface where the absorption of air, water and nutrients takes place that sustains the life of the tree.

The root system of a tree grows mainly within the top 60 cm of the surface of good quality, well drained and uncompacted soil.

The root system can extend to more than 2 to 3 times the **dripline** distance.

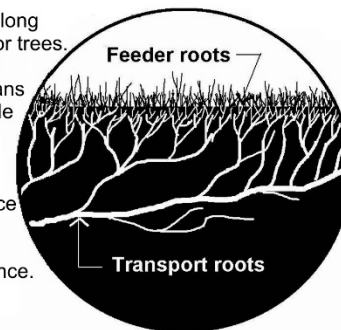


Figure 1: Urban Forestry Detail TP-3

2. Protecting Trees

There are a number of steps that can be taken to protect trees prior to, during and after any construction project. Hiring an arborist should be the first step. An arborist can advise on current tree maintenance requirements and determine the impact the proposal will have on trees and the surrounding natural environment.

An inventory of trees on subject and adjacent properties that may be impacted by the proposed work should be prepared in accordance with the City tree by-laws so that the project can be designed with tree protection in mind. A tree protection plan prepared by an arborist will identify the location, species, size and condition of all trees within the area of consideration, identify the extent of injury where applicable and outline proposed tree protection measures for the trees identified for protection.

The **area of consideration** for trees protected under the Private Tree By-law (Municipal Code, Chapter 813, Article III) includes the entire area of site disturbance, including construction related traffic and material storage, and extends 6m beyond the limit of site disturbance. For trees protected under Ravine and Natural Feature Protection By-law (Municipal Code, Chapter 658), the area of consideration includes the area of site disturbance and 12m area beyond.

The following chart provides the required distances for determining a **minimum tree protection zone** (TPZ) for trees located on a City street, in parks and on private property subject to Private Tree By-law and for trees located in areas regulated under the Ravine and Natural Feature Protection By-law. The minimum tree protection zones are based on the diameter of the tree. While these guidelines provide minimum protection distances for the anchor and transport roots of a tree, there can still be significant loss of the feeder roots beyond the established tree protection zone. Feeder roots are responsible for water and nutrient absorption and gas exchange. **For this reason, Urban Forestry may require a TPZ larger than the minimum, depending on the tree and the surrounding environment.**

Trunk Diameter (DBH) ¹	Minimum Protection Distances Required ² City-owned and Private Trees	Minimum Protection Distances Required Trees in Areas Protected by the Ravine and Natural Feature Protection By-law
		Whichever of the two is greater:
<10cm	1.2 m	The drip line ⁴ or 1.2 m
10- 29 cm	1.8 m	The drip line or 3.6 m
30 ³ – 40 cm	2.4 m	The drip line or 4.8 m
41 – 50 cm	3.0 m	The drip line or 6.0 m
51 – 60 cm	3.6 m	The drip line or 7.2 m
61 – 70cm	4.2 m	The drip line or 8.4 m
71 – 80cm	4.8 m	The drip line or 9.6 m
81 – 90 cm	5.4 m	The drip line or 10.8 m
91 – 100 cm	6.0 m	The drip line or 12.0 m
>100 cm	6 cm protection for each 1 cm diameter	12cm protection for each 1 cm diameter or the drip line ⁵

Table 1: Minimum Tree Protection Zone (TPZ) Determination

¹Diameter at breast height (DBH) measurement of tree stem taken at 1.4 metres (m) above the ground.

²Minimum Tree Protection Zone distances are to be measured from the outside edge of the tree base.

³Diameter (**30 cm**) at which trees qualify for protection under the Private Tree By-law.

⁴The drip line is defined as the area beneath the outer most branch tips of a tree.

⁵Converted from ISA Arborists' Certification Study Guide, general guideline for tree protection barriers of 1 foot of diameter from the stem for each inch of stem diameter.

The diagram below shows how the TPZ is determined:

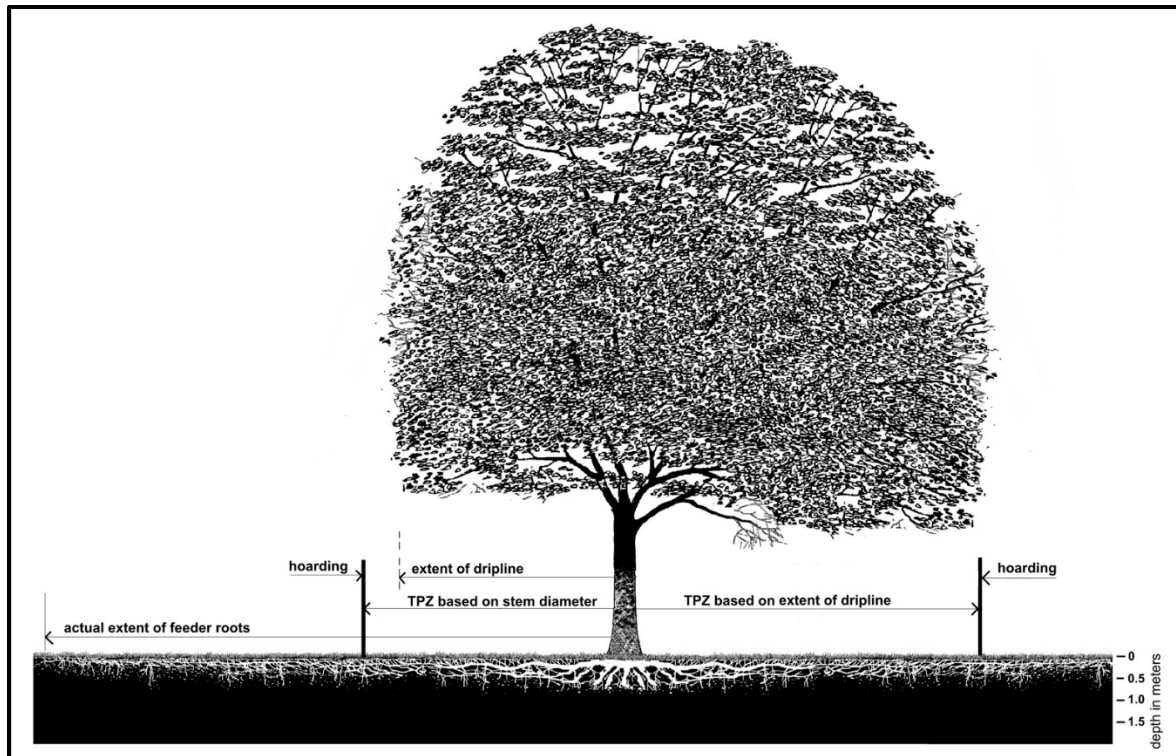


Figure 2: Minimum Tree Protection Zone (TPZ) Determination

In some cases, disturbances in the TPZ may be unavoidable, in which case, the TPZ must be adjusted in consultation with the arborist and Urban Forestry. In these situations, it may be necessary to implement other tree protection measures such as horizontal root protection as noted in section 3 of this document.

In addition to establishing and creating tree protection zones, it may be necessary to implement other protective measures, such as adding mulch to the root zone, aeration of the soil, pruning for deadwood or removing limbs that may be impacted by construction activity. This is also the time to determine the location where new trees can be planted to compliment the construction project and help with the renewal and growth of the urban forest.

Prior to commencing with any excavation, roots approved for pruning by Urban Forestry must first be exposed using pneumatic (air) excavation, by hand digging or by using a low pressure hydraulic (water) excavation. This **exploratory excavation** must be undertaken by an experienced operator under the supervision of a qualified and experienced arborist. The water pressure for hydraulic excavation must be low enough that root bark is not damaged or

removed. This will allow a proper pruning cut and minimize tearing of the roots. The arborist retained to carry out root pruning must contact Urban Forestry no less than three (3) working days prior to conducting any specified work.

Exploratory excavation may also be required for open face cuts outside the minimum tree protection zone (TPZ).

Communication between owners and their designated agents, arborists, contractors and sub-contractors throughout the construction process is critical to ensure that everyone involved is aware of the issues surrounding tree protection, and fully understands the tree protection methodology. Construction damage to trees is often irreversible.

Prohibited Activities Within a TPZ

Except where authorized by Urban Forestry, any activity which could result in injury or destruction of a protected tree or natural feature, or alteration of grade within a Ravine and Natural Feature Protection (RNFP) area, is prohibited within a TPZ, including, but not limited to, any of the following examples:

- demolition, construction, replacement or alteration of permanent or temporary buildings or structures, parking pads, driveways, sidewalks, walkways, paths, trails, dog runs, pools, retaining walls, patios, decks, terraces, sheds or raised gardens
- installation of large stones or boulders
- altering grade by adding or removing soil or fill, excavating, trenching, topsoil or fill scraping, compacting soil or fill, dumping or disturbance of any kind
- storage of construction materials, equipment, wood, branches, leaves, soil or fill, construction waste or debris of any sort
- application, discharge or disposal of any substance or chemical that may adversely affect the health of a tree e.g. concrete sludge, gas, oil, paint, pool water or backwash water from a swimming pool
- causing or allowing water or discharge, to flow over slopes or through natural areas
- access, parking or movement of vehicles, equipment or pedestrians
- cutting, breaking, tearing, crushing, exposing or stripping tree's roots, trunk and branches.
- nailing or stapling into a tree, including attachment of fences, electrical wires or signs
- stringing of cables or installing lights on trees
- soil remediation, removal of contaminated fill
- excavating for directional or micro-tunnelling and boring entering shafts

The above mentioned prohibitions are for area(s) designated as a TPZ. If possible, these prohibitions should also be implemented outside the TPZ in areas where tree roots are located. The roots of a tree can extend from the trunk to approximately 2-3 times the distance of the dripline.

3. Tree and Site Protection Measures

The following are examples of specific tree and site protection measures that may be required by Urban Forestry:

- Plywood tree protection hoarding (minimum 19mm or ¾"), or equivalent barriers, as approved by Urban Forestry, shall be installed in locations as detailed in an Urban Forestry approved Tree Protection Plan. Tree protection barriers must be made of 2.4m (8ft) high plywood hoarding or equivalent as approved by Urban Forestry. Height of hoarding may be less than 2.4m (8ft), to accommodate tree branches that may be lower, or as approved by Urban Forestry. Within a City road allowance where visibility is a consideration, 1.2m (4ft) high orange plastic web snow fencing on a 38 x 89mm (2"x 4") frame should be used. The detail on tree protection barrier construction is shown on Figure 4 in section 7 of this document
- In specific situations where the required full minimum tree protection zone (TPZ) cannot be provided, a **horizontal** (on grade) **root protection**, designed by a qualified professional such as arborist or landscape architect, may be considered, subject to approval by Urban Forestry. Urban Forestry's objective is zero soil compaction within the tree protection zone, therefore best efforts must be made to achieve this objective using materials and best practices available that minimize the vertical loading and spread the loading horizontally.
- Any area designated for stockpiling of excavated soil must be outside of TPZs and be enclosed with sediment control fencing. Sediment control fencing shall be installed in the locations as indicated in an Urban Forestry approved Tree Protection Plan. The sediment control fencing must be installed to Ontario Provincial Standards (OPSD-219.130 – see Section 7, Figure 5) and to the satisfaction of Urban Forestry. When feasible, the sediment control fencing can be attached to the tree protection barrier as shown in Figure 6. Sediment control fencing near trees shall be constructed as per detail shown on Figure 6 of this document

4. Tree Protection Signage

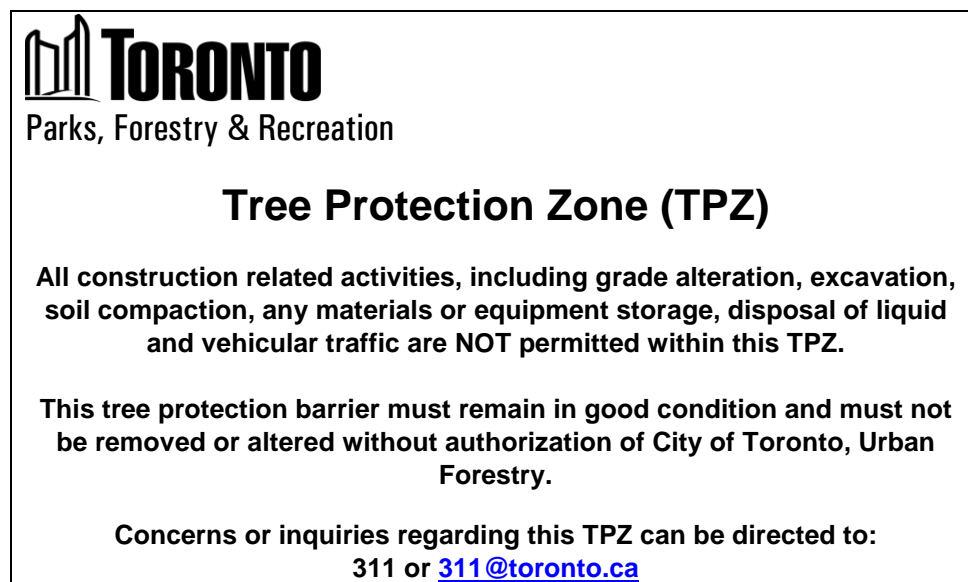


Figure 3: Tree Protection Sign

A sign that is similar to the illustration above may be required to be mounted on all sides of a tree protection barrier for trees protected by the Street Tree By-law and the Private Tree By-law. The sign should be a minimum of 40cm x 60cm and made of white corrugated plastic board or equivalent material. The sign may also be acquired from Urban Forestry Tree Protection and Plan Review (TPPR) district service counters.

5. Tree Protection Plan

All construction related applications must include a Tree Protection Plan that shows details of tree protection, prepared in conjunction with an arborist report or in consultation with an arborist, when protected trees are in proximity to the proposed work. All Tree Protection Plans must be legible, prepared at a usable metric scale and include the following information:

- Show all existing buildings, structures, hard surfaces and all existing trees within the area of consideration (as defined in Section 2 of this document). Depending on the extent of site disturbance, trees on neighbouring properties may need to be included. Note that area of disturbance must include all areas that will be disturbed by the proposed work, including the areas required for over-dig, stockpiling, construction traffic, vehicular access and construction staging
- The extent of the crown (drip line) or the extent of minimum tree protection zone TPZ (whichever is greater) of each existing tree
- Proposed changes on site, including all proposed structures, services, hard surfaces and grade changes
- Indicate vehicular access and construction staging areas. Areas proposed for temporary stockpiling of fill or excavated material shall be fenced with sediment control to prevent sediment runoff
- Indicate location of any excavation that requires root pruning
- Indicate trees proposed to be removed and/or injured
- Highlight and label tree protection barriers and the proposed tree protection zones. (See Table 1 to determine size of tree protection zone. Distances are to be measured from base of tree)
- The extent of proposed tree injury, where applicable.
- Include a comprehensive legend

See Section 6, Tree Protection Plan Notes, and Section 7, Tree Protection Plan Details, for further information.

6. Tree Protection Plan Notes

The following notes are to be included on tree protection plans submitted for construction related applications:

General Notes

- It is the applicants' responsibility to discuss potential impacts to trees located near or wholly on adjacent properties or on shared boundary lines with their neighbours. Should such trees be injured to the point of instability or death the applicant may be held

responsible through civil action. The applicant would also be required to replace such trees to the satisfaction of Urban Forestry

- Tree protection barriers shall be installed to standards as detailed in this document and to the satisfaction of Urban Forestry
- Tree protection barriers must be installed using plywood clad hoarding (minimum 19mm or ¾" thick) or an equivalent approved by Urban Forestry
- Where required, signs as specified in Section 4, Tree Protection Signage must be attached to all sides of the barrier
- Prior to the commencement of any site activity such as site alteration, demolition or construction, the tree protection measures specified on this plan must be installed to the satisfaction of Urban Forestry
- Once all tree/site protection measures have been installed, Urban Forestry staff must be contacted to arrange for an inspection of the site and approval of the tree/site protection requirements. Photographs that clearly show the installed tree/site protection shall be provided for Urban Forestry review
- Where changes to the location of the approved TPZ or sediment control or where temporary access to the TPZ is proposed, Urban Forestry must be contacted to obtain approval prior to alteration
- Tree protection barriers must remain in place and in good condition during demolition, construction and/or site disturbance, including landscaping, and must not be altered, moved or removed until authorized by Urban Forestry
- No construction activities including grade changes, surface treatments or excavation of any kind are permitted within the area identified on the Tree Protection Plan or Site Plan as a minimum tree protection zone (TPZ). No root cutting is permitted. No storage of materials or fill is permitted within the TPZ. No movement or storage of vehicles or equipment is permitted within the TPZ. The area(s) identified as a TPZ must be protected and remain undisturbed at all times
- All additional tree protection or preservation requirements, above and beyond the installation of tree protection barriers, must be undertaken or implemented as detailed in the Urban Forestry approved arborist report and/or the approved tree protection plan and to the satisfaction of Urban Forestry
- If the minimum tree protection zone (TPZ) must be reduced to facilitate construction access, the tree protection barriers must be maintained at a lesser distance and the exposed portion of TPZ must be protected using a horizontal root protection method approved by Urban Forestry
- Any roots or branches indicated on this plan which require pruning, as approved by Urban Forestry, must be pruned by an arborist. All pruning of tree roots and branches must be in accordance with good arboricultural practice. Roots that have received approval from Urban Forestry to be pruned must first be exposed using pneumatic (air) excavation, by hand digging or by a using low pressure hydraulic (water) excavation. The water pressure for hydraulic excavation must be low enough that root bark is not damaged or removed. This will allow a proper pruning cut and minimize tearing of the roots. The arborist retained to carry out crown or root pruning must contact Urban Forestry no less than three working days prior to conducting any specified work
- The applicant/owner shall protect all by-law regulated trees in the area of consideration that have not been approved for removal throughout development works to the satisfaction of Urban Forestry

- Convictions of offences respecting the regulations in the Street Tree By-law and Private Tree By-law are subject to fines. A person convicted of an offence under these by-laws is liable to a minimum fine of \$500 and a maximum fine of \$100,000 per tree, and /or a Special Fine of \$100,000. The landowner may be ordered by the City to stop the contravening activity or ordered to undertake work to correct the contravention
- Prior to site disturbance the owner must confirm that no migratory birds are making use of the site for nesting. The owner must ensure that the works are in conformance with the Migratory Bird Convention Act and that no migratory bird nests will be impacted by the proposed work

The following additional notes shall be added on plans for properties regulated by the Ravine and Natural Feature Protection Bylaw:

- Ravine and Natural Feature Protection By-law (RNFP) note:

Ravine & Natural Feature Protection By-law

The Ravine & Natural Feature Protection By-law, Chapter 658 of the City of Toronto Municipal Code, regulates the injury and destruction of trees, dumping of refuse and changes to grade within protected areas.

Under this by-law protected trees may not be removed, injured or destroyed, and protected grades may not be altered, without written authorisation from Urban Forestry Ravine & Natural Feature Protection, on behalf of the General Manager of Parks, Forestry & Recreation.

Convictions of offences respecting the regulations in the Ravine and Natural Feature Protection By-law are subject to fines, and the landowner may be ordered by the court to restore the area to the satisfaction of the City. A person convicted of an offence under this Bylaw is liable to a minimum fine of \$500 and a maximum fine of \$100,000 for each tree destroyed, a maximum fine of \$100,000 for any other offence committed under this chapter, and /or a Special Fine of \$100,000. A person convicted of a continuing offence, including failure to comply with ravine permit conditions is liable to a maximum fine of not more than \$10,000 for each day or a part of a day that the offence continues.

- The exact location of the limit of the RNFP area must be shown on all pertinent plans including Tree Protection Plan. The applicant/owner shall have this limit marked on their survey or other plans drawn to a suitable scale. This service costs \$72.37 plus tax and can be requested by contacting the City of Toronto, Information and Technology, Geospatial Competency Centre, Map Service Counter at 416-392-2506 or mapsales@toronto.ca. This line may then be transferred onto other plans to be submitted.
- Sediment control fencing shall be installed in the locations as indicated in the Urban Forestry approved sediment control plan. The sediment control fencing must be installed to Ontario Provincial Standards (OPSD-219.130, see Section 7, Figure 5) and to the satisfaction of Urban Forestry. Sediment control near trees and over root zones shall be installed as shown on Figure 6 of this document and to the satisfaction of Urban Forestry.

7. Tree Protection Plan Details

The following diagrams provide details for tree protection barriers and sediment protection barriers:

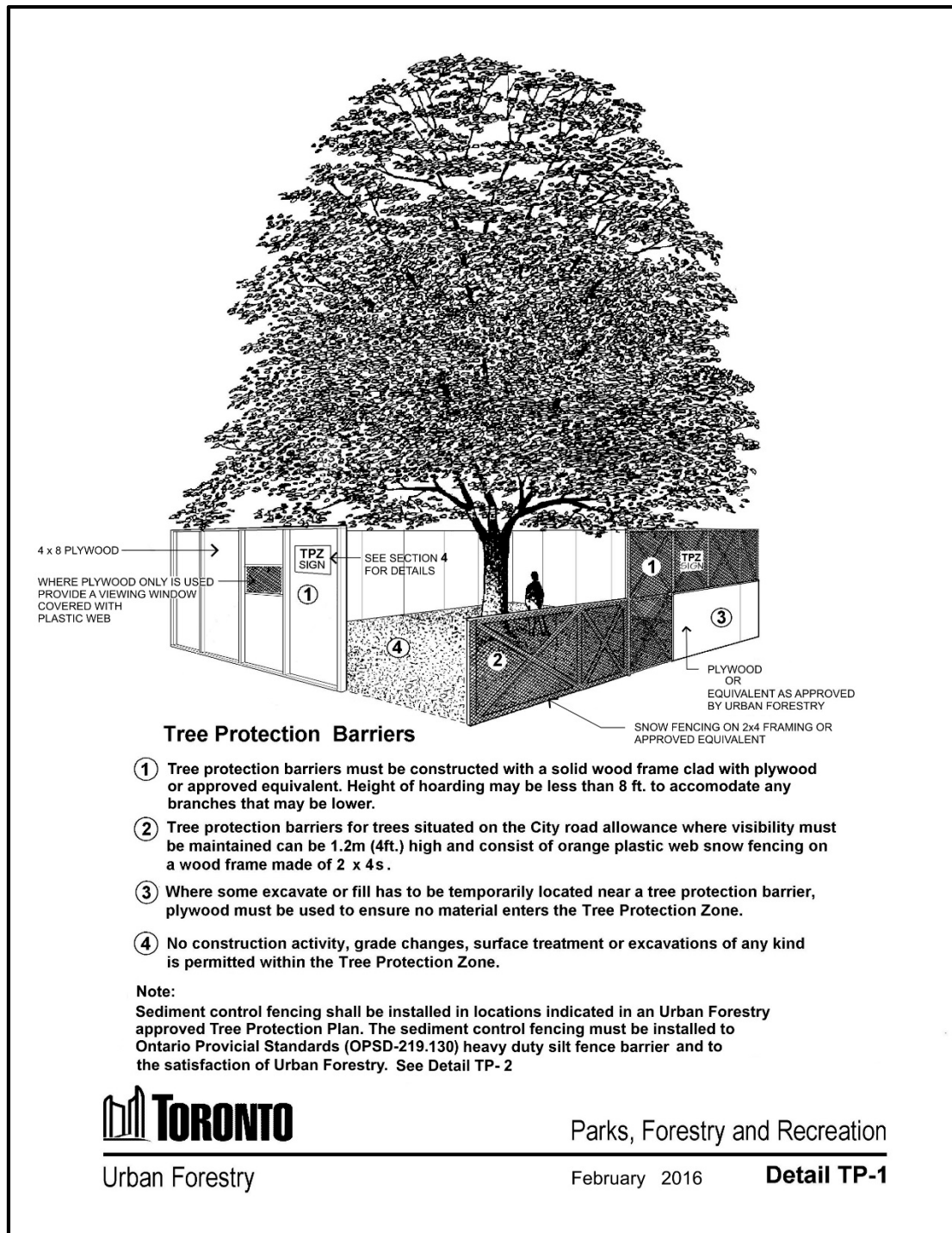


Figure 4: Urban Forestry Detail TP-1

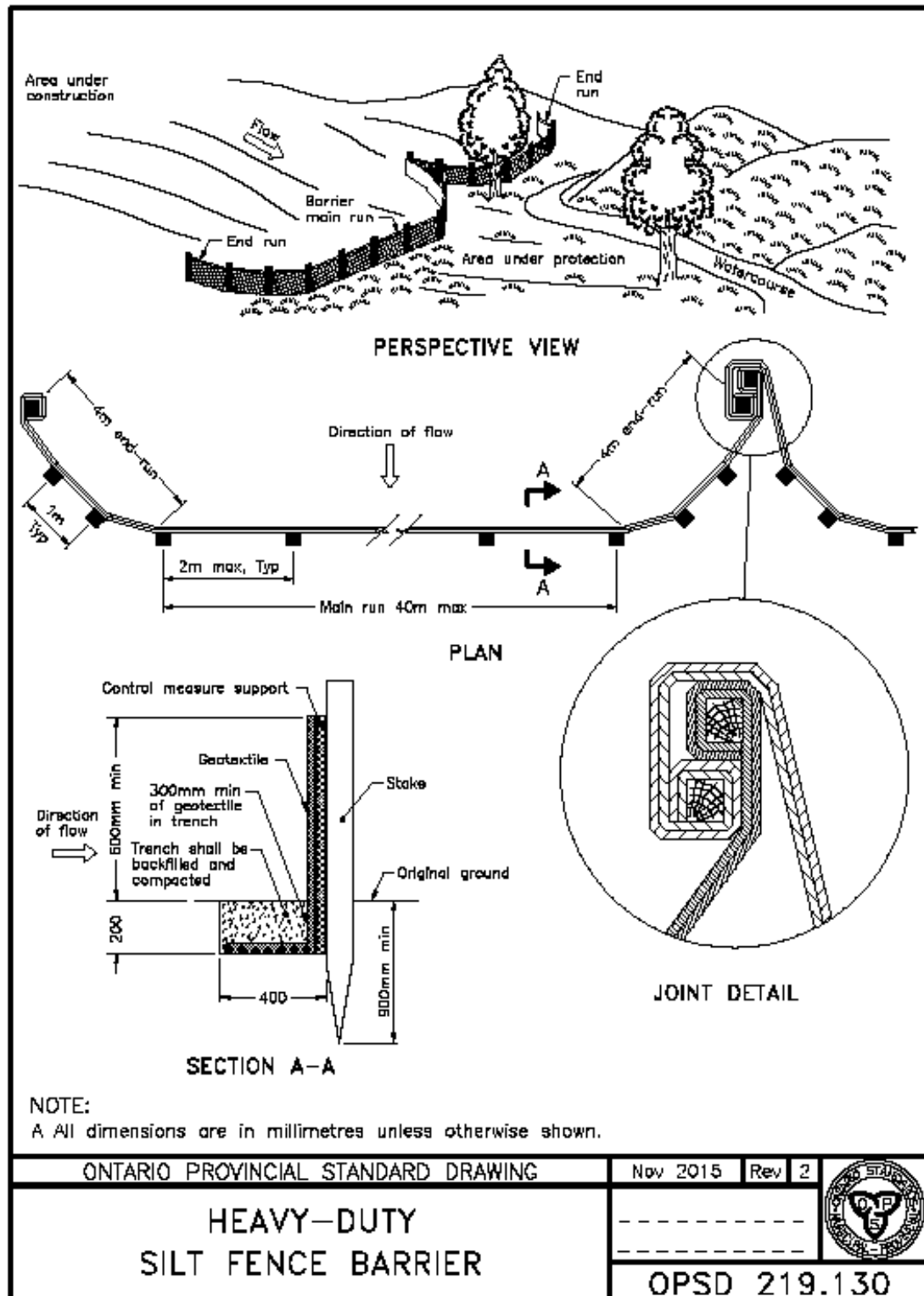


Figure 5: OPSD Detail for Heavy Duty Silt Fence Barrier

The following detail shall be used when constructing sediment protection fencing near trees.

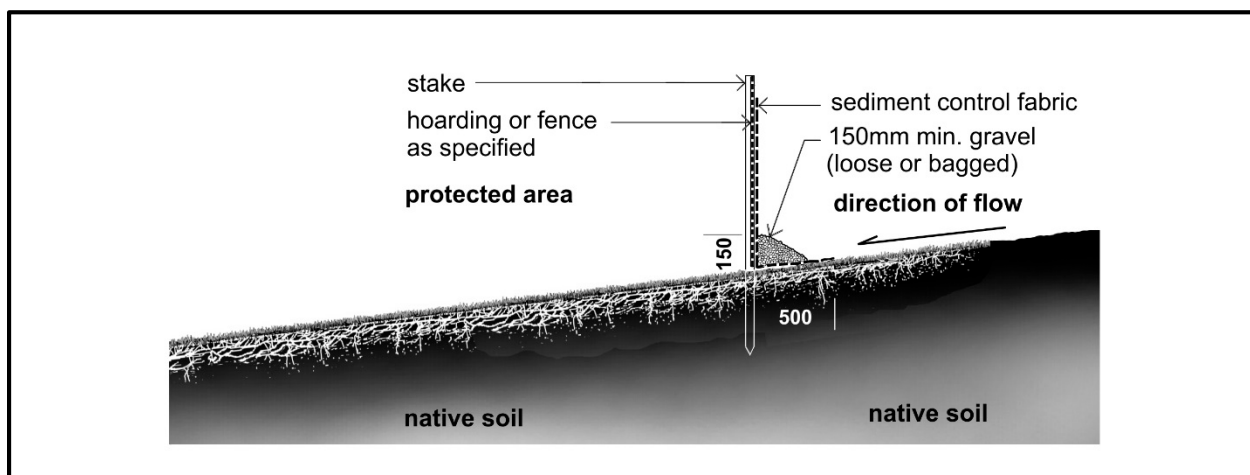


Figure 6: Sediment control barriers for use over tree root zone

8. Permits for Tree Removal or Injury

If the full minimum tree protection zone (TPZ) as identified in Section 2 cannot be provided, a permit to injure the tree must be obtained.

Any requests for removal or injury of a tree protected by City by-laws must be made on the appropriate application forms and submitted to Urban Forestry at the appropriate address. [Permit application forms](#) are available at www.toronto.ca/trees. Any requests for tree relocation will be considered as a tree injury.

If approval is granted for removal of a City-owned tree, applicants will assume all costs involved, which include appraised tree value, removal, and tree replacement costs. If approval is granted for removal of private trees or trees in ravine and natural feature protected areas, the permit will be subject to conditions, including tree replacement. If approval is granted for injury of City-owned, private trees or trees in ravine and natural feature protected areas, the permit will be subject to conditions, including implementation of a Tree Protection Plan, as determined by Urban Forestry.

In some instances, where the tree is healthy and the management of the tree or forest cover has not been addressed to the satisfaction of Urban Forestry, requests received by Urban Forestry may be forwarded to a Community Council and City Council for approval.

Urban Forestry does not have the authority to issue a permit to injure or remove a heritage tree². Such requests would be forwarded to a Community Council and/or City Council for approval.

Butternut (*Juglans cinerea*, L.) is an endangered species. Butternuts and their habitat are protected under [Endangered Species Act](#) (S.O. 2007, c.6) available on the Government of Ontario website at <http://www.ontario.ca/laws/statute/07e06/v1>. A permit to injure or remove a butternut tree must be obtained from the [Ministry of Natural Resources and Forestry Ontario](#).

² Heritage Tree – A tree that has been designated under Part IV of the Ontario Heritage Act or trees recognized as heritage trees by the Ontario Heritage Tree Program of Trees Ontario.

Any person who contravenes any provision of the City's tree protection by-law is guilty of an offence.

More information on tree protection and permit application forms for tree removal and injury are available on Urban Forestry web page at www.toronto.ca/trees.

For additional information regarding the removal or injury of trees protected under City by-laws, please call 311.

9. Tree Guarantee Deposits

Tree Protection Guarantee

Urban Forestry may request a **tree protection guarantee** to secure the protection of trees that may be impacted by work on city streets, or to secure the satisfaction of all conditions of permit issuance. Tree protection guarantees held by the City shall only be released by the City provided that all construction activities are complete, compliance with all permit terms and conditions has been verified, there has been no encroachment into the minimum tree protection zone (TPZ) and the trees are healthy and in a state of vigorous growth.

Where Urban Forestry has confirmed an unauthorized encroachment into the TPZ or the terms and conditions of a permit have not been complied with, Urban Forestry will retain the guarantee until satisfactory compliance.

It is the applicant's responsibility to submit a written request to Urban Forestry for the refund of the tree protection guarantee deposit as soon as construction and landscaping is completed.

Tree Planting Security

Urban Forestry may request a **tree planting security deposit** in an amount equal to the cost of planting and maintenance for two (2) years in order to ensure compliance with approved landscape or replanting plans. The security deposit may be held by the City after the planting of the trees for a period of two (2) years and shall be released by the City provided that the trees have been maintained, are healthy and in a state of vigorous growth upon inspection, two (2) years after planting. It is the applicant's responsibility to advise Urban Forestry that trees have been planted in accordance with approved plans, in order that the two (2) year maintenance period begin.

Prior to release by the City, any dead/dying trees must be replaced, deadwood and sucker growth should be pruned, and mulch should be topped up where necessary. If stakes and ties were used, they must be removed within one (1) year. Any encroachments are to be removed prior to assumption, including walkways, timbers or bricks that result in increased height of soil or mulch around the trees, and lights in trees.

It is the applicant's responsibility to submit a written request to Urban Forestry for the refund of a Tree Guarantee Deposit, two (2) years after the completion of all construction activity and/or two (2) years after tree planting. This request should be made during the growing season, not while

the trees are dormant, so that a site inspection can be arranged to confirm the trees are acceptable. The City will not release security deposits where trees are not in good condition, or if there are encroachments.

Financial securities must be in the form of a certified cheque, letter of credit or an alternative acceptable to Urban Forestry, with amounts payable to the Treasurer, City of Toronto.

10. Emergency Repairs to Utilities

The utility company is responsible for notifying Urban Forestry by calling 311 as soon as possible when by-law regulated trees are involved, so that an inspector can be dispatched. Urban Forestry staff may be contacted after hours by calling 311, and requesting the assistance of an on-call Urban Forestry inspector.

11. Tree Species that are Intolerant of Construction Disturbance

The following tree species are intolerant of construction disturbance, and tree protection plans must take this into account. The tree protection zones required by these species may need to be quite extensive to avoid damage to the roots and crown associated with compaction, excavation or construction above grade that will impact the branches.

Acer rubrum (red maple)
Acer saccharum (sugar maple)
Betula papyrifera (paper birch)
Carya glabra (pignut hickory)
Fagus grandifolia (American beech)
Liriodendron tulipifera (tulip tree)
Ostrya virginiana (ironwood)
Pinus resinosa (red pine)
Pinus strobus (white pine)
Prunus serotina (black cherry)
Quercus alba (white oak)
Quercus velutina (black oak)
Tsuga canadensis (eastern hemlock)
Tilia americana (basswood)

12. Contact Information

Tree Protection and Plan Review (City-owned and Private Trees)

North York District

5100 Yonge Street, 3rd Floor
Toronto, ON, M2N 5V7
Telephone: 416-395-6670
Fax: 416-395-7886
tpprnorth@toronto.ca

Etobicoke York District

399 The West Mall, Main Floor, North Block
Toronto, ON, M9C 2Y2
Telephone: 416-338-6596
Fax: 416-394-8935
tpprwest@toronto.ca

Scarborough District

150 Borough Drive, 5th Floor
Toronto, ON, M1P 4N7
Telephone: 416-338-5566
Fax: 416-396-4170
tppreast@toronto.ca

Toronto and East York District

50 Booth Avenue, 2nd Floor
Toronto, ON, M4M 2M2
Telephone: 416-392-7391
Fax: 416-392-7277
tpprsouth@toronto.ca

Ravine and Natural Feature Protection

General Enquiries

Telephone: 416-392-2513
Fax: 416-392-1915
Email: rnfp@toronto.ca

Office Location

18 Dyas Road, 1st Floor
Toronto, ON, M3B 1V5

Areas regulated under Ravine and Natural Feature Protection By-law can be viewed using the [City's mapping tool](#) available at www.toronto.ca/trees.



City of Toronto - Commercial Facilities

Structured Cabling Systems

Design Guide For

Consulting Engineers, Architects, Designers

& Contractors

Revision: 1.0

January 2023

Corporate Services | Network Services

Information Technology

Standards & Procedures

REVISION HISTORY

Version	Version Date	Issued by	Changes in Document	Next Review Date
1.0	January 2023	Network Services (IT)	Document Created	December 2023

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SECTION-1: INTRODUCTION

This design guide is to provide consulting engineers, architects and designers working for the City of Toronto (CoT) with a document for the design of commercial facilities (owned, controlled, or leased buildings) communications distribution and structured cabling systems that accurately reflects the City of Toronto (CoT) and industry standards in effect as of this publication. This document shall be referenced to develop project specification and tender documents, specifically extra costs, and Bell standard pricing.

Therefore, it is obligatory for consulting engineers, architects, and designers of telecommunications systems of City of Toronto (CoT) to follow and practice the most updated revision to reflect the methods, materials and standards that have been used for providing telecommunications services to the existing facilities. The updated document also reflects changes in industry practice as of this publication.

In general, it is the responsibility of the building communications distribution designer to coordinate with the other designers on a project (architect, structural, electrical, mechanical, etc.) to ensure that other systems are both compatible with and complementary to the communications cabling system. The City of Toronto (CoT) design philosophy is that it is critical to coordinate between disciplines during the design phase of a project, rather than attempting to make adjustments in the field during construction.

Communications distribution systems designed for the City of Toronto (CoT) commercial facilities are expected to support and integrate voice, data and video communications with common media (fiber optic and unshielded twisted pair copper cable).

DOCUMENT INTENT AND LIFE CYCLE

The purpose of this standard is to define the general guidelines and standards for the design, specification, installation, testing, troubleshooting, documentation and handing over of the commercial facilities (owned, controlled, or leased) communications distribution and structured cabling systems. This standard follows published industry standards and best practices applicable to the commercial buildings of City of Toronto (CoT). The life cycle of this document version is from January to December every year from 2023. Always consult City of Toronto (CoT) Network Services (IT) Division for the latest version of this standard guide.

This document addresses commercial buildings communications distribution and structured cabling system design as it relates to:

- Design guide, topology and methodology
- Communications Media – fibreoptics and copper unshielded twisted pair (UTP)
- Pathway System – cable trays, conduits, etc.
- Products

- Execution (installation)
- Testing and Commissioning
- Handing over (final acceptance)

This document should serve as a guide for making standards compliant project specification which, in due course, will be reflected in a master tender specification document. In addition to specifications for a telecommunications project, plan drawings and schematic diagrams will also need to be produced by the designer. The drawings should conform to the guidelines contained in this document. This document is to be used in conjunction with the latest edition of BICSI TDMM.

Though every attempt is made to cover unforeseen issues, every building and project has its own issues, therefore IT - Network Services and Telecommunication Services should be included right at beginning of the project and the communications specifications must be reviewed and approved by these groups within the City of Toronto (CoT).

TYPES OF CONSTRUCTION

Throughout this document, reference will be made to three types of construction as defined below: new, overbuild and basic construction. These definitions are applicable to the purposes of this document only. A new commercial building communications distribution and structured cabling system as well as the addition to and/or modification of existing cabling system is included in these construction projects. Tradeoffs between design standards and practicality will many times be dependent upon the type of construction. Different design approaches may be warranted for differing types of construction.

A- NEW CONSTRUCTION

New construction is defined as construction that results in a new (or new portion of an existing) commercial buildings communications distribution and structured cabling systems. For the most part, new pathway will be constructed, and new cabling will be installed in the pathway.

B- OVERBUILD CONSTRUCTION

Overbuild construction is defined as construction which may include demolition and/or abandonment of existing pathway and cabling, reuse of existing pathway for installation of new cabling and/or the addition of new pathway and/or cabling to existing pathway and/or cabling. Common terms referring to this type of construction include expansion, renovation, remodel, addition and retrofit, among others.

C- BASIC CONSTRUCTION

Basic construction is defined as construction that includes reuse of existing distribution pathway for the installation of new cabling. Demolition of existing cabling may be involved as well. Basic construction is focused on the installation of new cabling with no (minor) modifications to the existing pathway system.

CITY OF TORONTO AGREEMENT WITH BELL CANADA FOR COMMERCIAL FACILITIES

Effective January 10, 2010, the City of Toronto (CoT) has entered into a multiyear Voice and Data cabling agreement with Bell Canada. Bell Canada is to be used for all Data and Voice cabling for all owned and leased buildings of the City of Toronto.

A pricing table of services regarding this agreement having unit cost is available to share from CoT-IT with the permission to only authorized recipients.

Based on the agreement, current cabling vendor of record (VOR) shall be used. The cabling VOR shall be verified by CoT-IT Network Services at the time of proposed work or RFP.

Analog devices such as fax, POS (dialup), modems and other specialized monitoring lines are using Centrex. The voice cabling system for Centrex will be supplied and installed by Bell as part of an agreement between Bell and the City of Toronto. Bell will have ownership of the voice cabling system.

Please contact CoT-IT-Telecommunications Services, voice infrastructure group for more details.

CITY OF TORONTO TENDER DRAWINGS

This standard guide should be read in conjunction with the City of Toronto (CoT) standard drawings. The drawings shall typically be produced by the consulting engineers / designers and shall consist of (if applicable to the project) the followings but not be limited to:

1. Title Page and Drawing Index
2. Symbols (legends) and Notes General
3. Campus / Building Layout – Fibreoptics Backbone Network Layout (if applicable)
4. Fibreoptics Patch Panel Port Assignment (if applicable)
5. Campus / Building Layout – Voice (copper) Backbone Network Layout (if applicable)
6. Copper Patch Panel / BIX Blocks Port Assignment
7. Building Floor Plan
8. Serving Zone Floor Plan
9. Wireless Heatmap Plan
10. Entrance Facility Layout
11. Equipment Room Layout

12. Telecom Room Layout
13. Building Riser Layout – Horizontal / Backbone
14. Ceiling / Wall / Furniture / Floor Mounted Work Area Outlet Details and Bill of Materials
15. Telecom Enclosure Elevation and Bill of Materials
16. Telecom Enclosure Power Distribution Diagram
17. Telecom Enclosure UPS Panel Layout
18. Entrance Facility Backboard Elevation and Bill of Materials
19. Telecom Pathways (Cable Trays / Conduits) Layout
20. Typical Details of Cable Tray, Conduit / Sleeve, Fire-stopping, Horizontal/Backbone Labeling
21. Telecom Grounding and Bonding Layout (Riser and Floor Plan)
22. HVAC – Mechanical System Layout for Equipment Room / Telecom Room
23. Electrical / Power Layout for Equipment Room / Telecom Room / Work Areas
24. Demolition Drawings (all applicable drawings / layouts – if applicable)

SERVICES NOT PROVIDED BY THE CITY OF TORONTO

- The voice system technology (Bell Centrex etc.) shall be supplied and installed by Bell Canada.
- Entrance Facility and demarcation point shall be outlined in the specific design drawings. Service providers shall terminate the incoming copper cables on BIX and BIX cross-connect between the ISP and the OSP cabling at the Entrance Facility.
- Service providers shall terminate the incoming fibre cables in either wall mount or rack mount fibre enclosures between the ISP and the OSP cabling at the Entrance Facility.
- Witnessing field cable testing at site is NOT CoT's responsibility. The Contractor shall submit the test results to Consultant for their review, validation, witnessing and comment. Consultant shall forward the test results to CoT-IT/Network Services for further review (only if approved by the Consultant after their review). If there is no Consultant on the project, the contractor/cabling installer shall submit the test results to CoT's IT/Network Services for their review.
- BOQs/BOMs, layouts, elevations, drawings and schematics shall be prepared/reviewed by the Consultant.

MANDATORY DESIGNERS' QUALIFICATION REQUIREMENTS

- The standard is to be observed by the City of Toronto - IT Network Services Staff and Consultants involved with the design and implementation of structured cabling systems for data networks which include data networks, security networks, VoIP networks and any other networks that require a structured cabling system that is unified and connected to the City of Toronto network.
- The preparation and review of any network cabling system design, drawings and specification documents shall be conducted by a **Registered Communications Distribution Designer (RCDD)**. The credential holder shall be in good standing who have demonstrated knowledge in the design, integration and implementation of telecommunications and data communications transport systems and related infrastructure.
- All consultant design drawings and specification document shall be sealed / stamped by RCDD.
- All cabling is to be provided from the manufacturers noted with the following sections. Cabling provided by alternate manufacturers is not acceptable.

In addition, the RCDD shall have the following qualifications:

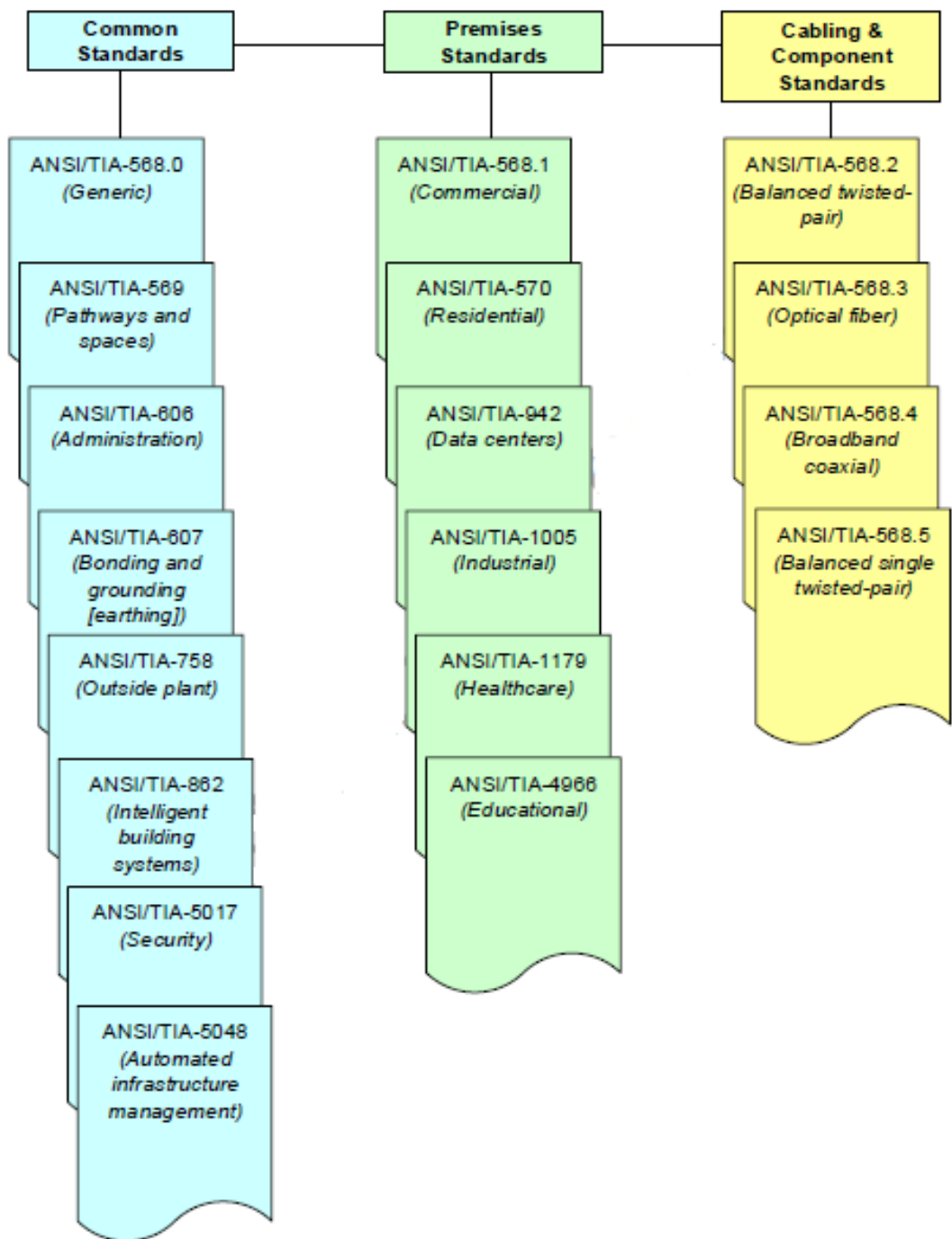
- The RCDD shall demonstrate a minimum of 5 years of experience in the design of commercial buildings communications distribution systems. Experience not directly related to the design and installation of commercial buildings communications distribution systems, such as sales and/or marketing, is not acceptable.
- The RCDD shall demonstrate that he/she has designed or has had personal design oversight of a minimum of five projects similar in size and construction cost to the current CoT project.
- The RCDD consultant must have verifiable design experience with products and solutions from **Belden**.

Before commencing any work for or on behalf of the City of Toronto, the RCDD shall provide a copy of their RCDD certificate showing up to date registration in accordance with the **Building Industry Consultant Services International (BICSI)** policies and guidelines.

MANUFACTURERS

In addition to the standards listed below, the City of Toronto has selected **Belden** as a manufacturer of communications cabling infrastructure products for commercial buildings. The manufacturer is identified in the Product Section. The commercial building communications distribution designer is required to incorporate only this manufacturer into the design and to design a communications distribution structured cabling system that will be suitable for the use of products from the manufacturer.

ANSI/TIA RELATIONSHIP DIAGRAM



Relationships between ANSI/TIA Standard Documents

DESIGN AND REFERENCE STANDARDS

It is required that the designer be thoroughly familiar with the content and intent of these references, standards, and codes and that the designer be capable of applying the content and intent of these references, standards, and codes to all commercial communications system designs executed on behalf of the City of Toronto.

Listed in the table below are references, standards, and codes applicable to commercial communications systems design. If questions arise as to which reference, standard, or code should apply in a given situation, the more stringent shall prevail. As each of these documents is modified over time, the latest edition and addenda to each of these documents is considered to be definitive.

Standard	Title	Date
TIA-568.0-E	Generic telecommunications cabling for customer premises	2020
TIA-568.1-E	Commercial Building Telecommunications Cabling Standard	2020
TIA-568.2-D	Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted- Pair Cabling Components	2018
TIA-568.3-E	Optical Fibre Cabling Components Standard	2022
TIA-568.4-E	Broadband Coaxial Cabling and Components Standard	2022
TIA-568.5	Balanced Single Twisted-pair Telecommunications Cabling and Components Standard	2022
TIA 606-D	Administration standard for telecommunications infrastructure	2021
TIA- 607-D	Generic telecommunications bonding and grounding (earthing) for customer premises	2019
TIA-569-E	Telecommunications Pathways and Spaces	2019
TIA-758-B	Customer-Owned Outside Plant Telecommunications Infrastructure Standard	2012
TIA-942-B	Telecommunications Infrastructure Standard for Data Centers	2017
TIA-598-D	Optical Fibre Cabling Coding	2014

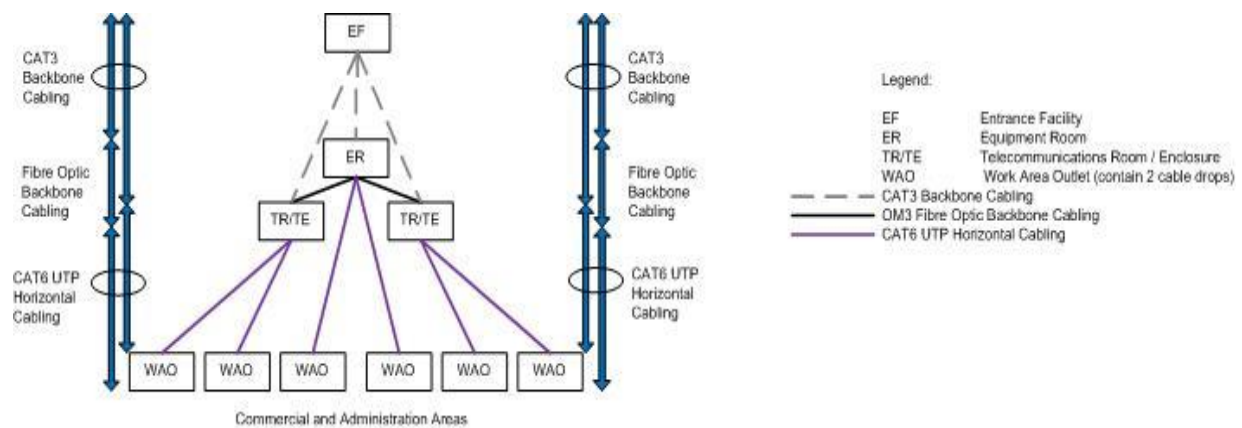
Standard	Title	Date
TIA-862-C	Structured Cabling Infrastructure Standard for Intelligent Building Systems	2022
TIA-1152-A	Requirements for field test instruments and measurements for balanced twisted-pair cabling	2016
TIA-1005-A	Telecommunications infrastructure standard for industrial premises	2012
TIA-526-14-C	Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; Modification of IEC 61280-4-1 edition 2, Fiber-Optic Communications Subsystem Test Procedures- Part 4-1: Installed Cable Plant-Multimode Attenuation Measurement	2015
TIA-526-7-A	Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fibre-Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-Mode Attenuation and Optical Return Loss Measurement	2015
TIA-TSB-162-B	Telecommunications Cabling Guidelines for Wireless Access Points	2021
TIA-TSB-184-A	Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling	2017
TIA-604-10-C	FOCIS 10 Fiber Optic Connector Intermateability Standard- Type LC	2021
BICSI TDMM	Telecommunications Distribution Methods Manual, 14th Edition	2020
ANSI/BICSI 002-2019	Data Center Design and Implementation Best Practices	2019
ANSI/BICSI 007-2020	Information Communication Technology Design and Implementation Practices for Intelligent Buildings and Premises	2020
ANSI/BICSI 008-2018	Wireless Local Area Network (WLAN) Systems Design and Implementation Best Practices	2018

CITY OF TORONTO - STRUCTURED CABLING SYSTEM - DESIGN CONSIDERATIONS

This section highlights design considerations of particular importance to City of Toronto (CoT). It also discusses different CoT construction arrangements (new, overbuild, or basic) for a particular project.

CITY OF TORONTO - COMMERCIAL BUILDING CABLING TOPOLOGY

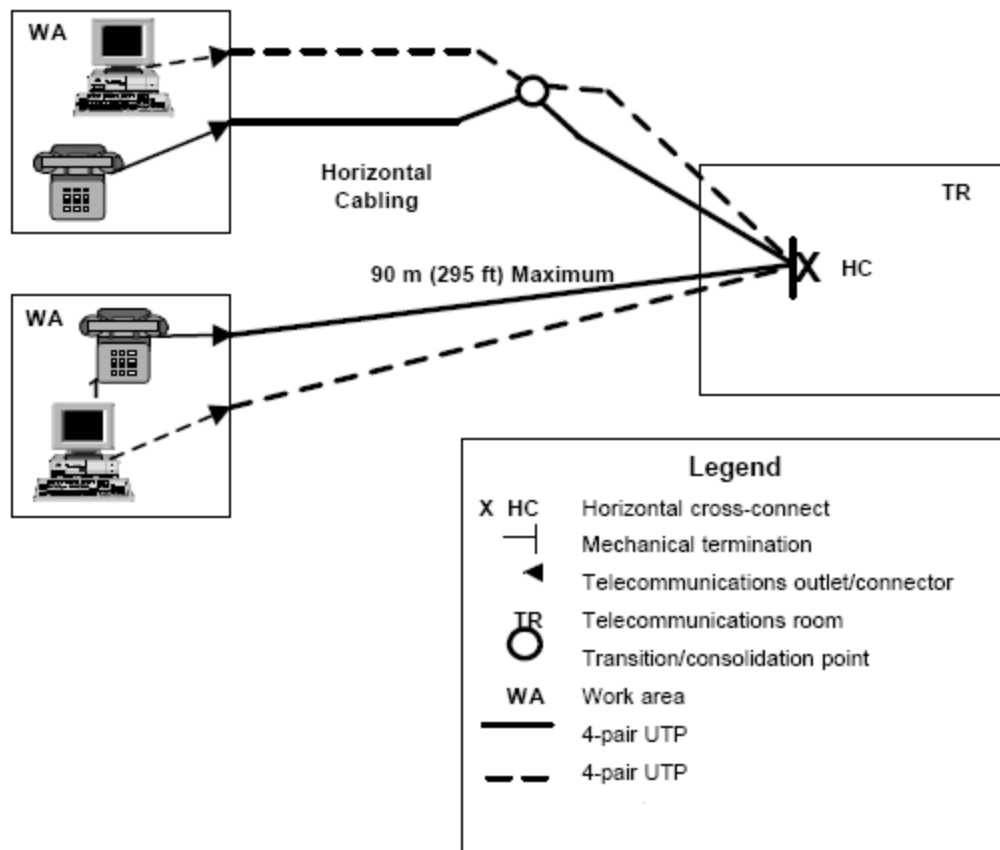
The figure below is an illustration of the City of Toronto commercial building cabling topology. Some of the cabling system such as CAT3/5e backbone, may or may not be applicable to the project.



Elements of the City of Toronto Standard Topology for Commercial Facilities

DESIGN SUMMARY

- The network shall be a distributed star topology network.
- All horizontal copper cables shall connect to the TE/TR from the WAO and fibre backbone cable shall connect to the ER (Server Room) from the TR/TE. The CAT3/5e backbone cabling from the TR/TE to the ER, may or may not be applicable to all the CoT projects.
- The specified copper network cables for all commercial buildings shall be Belden.
- The horizontal copper cable shall be U/UTP Category 6/6A and shall be in accordance to this specification.
- Length of the patch cables from WAO to the end device shall be in compliance to the Ethernet and structured cabling applicable standards.



- The backbone copper multi-pair (minimum 25 pairs) cable shall be U/UTP Category 3/5e and shall be in accordance to this specification. The multipair backbone, may or may not be applicable to all the CoT projects.
- The containment system for the voice and data network shall be as per the specified material mentioned in this document, unless specified otherwise on the design drawings/project scope. The approved conduit system is EMT type, appropriately sized as per TIA-569 standard. The cable tray shall be basket wire mesh type, corrosion resistant, standard sized as per TIA-569.
- The horizontal copper cables shall be permanently terminated at the patch panel in the Telecommunications Enclosure (TE) on one end, to a work-area outlet on the other end located on the walls of a commercial building.
- Horizontal cables in the commercial buildings shall always be collated of two (2) cables per work area outlet (WAO) located on the wall/furniture of the closed office or a cubicle.
- Office cubicles shall contain 1 WAO with 4 ports (1 Voice/VoIP, 1 Data and 2 Blank ports).

- Closed offices shall contain 1 WAO with 4 ports (1 Voice/VoIP, 1 Data and 2 Blank ports), shall be provided to every 10m² (100ft²) of office space (i.e. if the office is 10m² then it shall have 1 WAO). If the office is larger than 10m² (100ft²), then 2 WAOs shall be provided (with 2 Data and 2 Blank ports for the 2nd WAO).
- Each group of horizontal cables shall be associated with a single 4-port, work-area outlet on the wall/furniture and a 4-port, snap-in faceplate in the Telecommunication Enclosure patch panel.
- Approval for additional ports per cubicle or office must be granted by CoT IT/Network Services Technical Representative before proceeding with this work.
- Containment pathways shall be designed and sized for a minimum of four (4) horizontal cables, unless otherwise mentioned differently in the design drawings.
- The Fibre Optic Backbone is defined as the fibre optic segments radiating out from the Network Core Closet to the Telecommunications Enclosure/Room.
- The fibre allocation within the fibre optic backbone cable is as follows:
 - 12 Core fibre backbone: Multimode (OM4) and/or Singlemode (OS2)
 - City of Toronto LAN — 4 fibre strands active (2 primary, 2 redundant and 8 reserved)
 - All fibre cables shall be terminated and tested bi-directionally to the appropriate wavelengths (850/1300nm | 1310/1550nm) using calibrated certified testing equipment
- All passive network components shall be from a single manufacturer (Belden).
- The term "free-issue" refers to equipment supplied by the City. All the Network Switching and Routing Equipment will be freely issued by the City. The network equipment will be configured, tested and installed by City of Toronto IT/Network Services group.

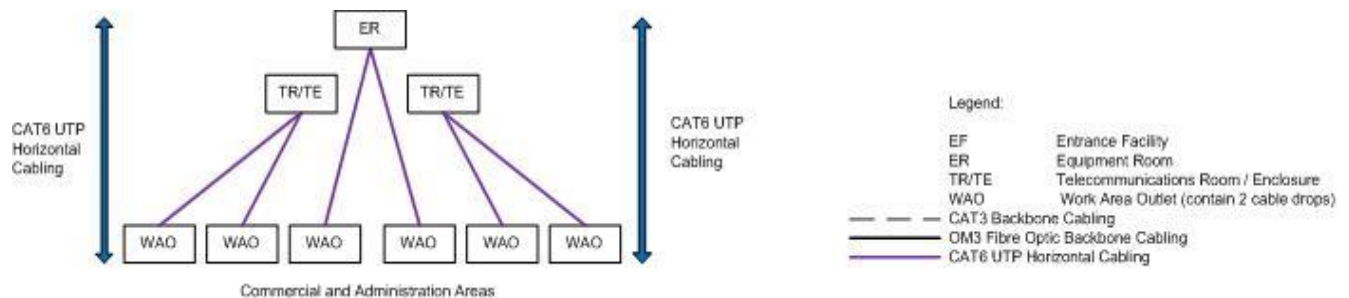
DESIGN DETAILS OF HORIZONTAL CABLING SYSTEM (CABLING SUBSYSTEM – 1)

Horizontal cabling includes installation cable, telecommunications connector/jack/module at the work area outlet (WAO), and mechanical terminations at both ends. Patch cords are required at WAO and TR/TE. Horizontal cabling length limitation requirements as specified in the ANSI/TIA-568.0-E and ANSI/TIA-568.1-E standards apply unless otherwise specified in this Standard.

TOPOLOGY

The horizontal cabling shall meet the star topology requirements of ANSI/TIA-568.0 and ANSI/TIA-568.1. Each telecommunication work area outlet (WAO)/connector/module shall be connected to the

horizontal cross-connect (HC) located at the TE/TR as shown in figure below. The horizontal installation cable shall be terminated on a jack/module (balanced twisted pair) at one or both ends.



Horizontal Cabling Topology

LENGTH

The horizontal cable length extends from the termination of the media on a patch panel at the TE/TR to the telecommunications connector/jack/module at the work area outlet (WAO). For balanced twisted-pair cabling the max permanent link length in the office/administration areas shall be 90m (295ft).

The length of the cross-connect/inter-connect jumper or patch cord at the cross-connect facility, including TE/TR, shall not exceed 5m (16ft) in the office/admin work area and 5m (16ft) in the TE/TR.

RECOGNIZED MEDIA

The recognized media, which shall be used individually or in combination, are:

- Minimum 4-pair 100 ohm balanced twisted-pair cabling, category 6 or higher
- 4-pair 100 ohm balanced twisted-pair cabling, category 6A (as per ANSI/TIA-568.2-D, preferred)

The Recognized media and associated connecting hardware, jumper, patch cord, equipment cord, and work area cord shall meet the requirements specified in this document.

CHOOSING MEDIA

Cabling specified by this Standard is applicable to different requirements within the commercial premises. Depending upon the characteristics of the individual application, choices with respect to transmission media should be made. In making this choice, factors to be considered include:

- Environmental classifications;
- Mitigation such as separation, protection or isolation;

- Cabling performance enhancements in accordance with performance test requirements;
- Applications to be supported by the cabling system;
- Equipment vendor recommendations or specifications;
- Configuration of cabling components;

The recognized cable has individual characteristics that make it suitable for a myriad of applications such as voice, data, video, automation and building controls, security, fire alarm, HVAC and audio visual (AV).

DESIGN DETAILS OF BACKBONE CABLING SYSTEM (CABLING SUBSYSTEM – 2 AND 3)

Backbone cabling is the portion of the commercial building telecommunications cabling system that provides interconnections between Entrance Facility (EF), Equipment Room/Server Room (ER) and Telecommunications Room/Enclosure (TR/TE). Primary and redundant, 12 strands in each cable shall run between the equipment room and the telecom room. Total of 2 x 12 strands shall run with diverse pathways between the equipment and telecom rooms. As such, the backbone cabling shall meet the requirements of ANSI/TIA-568.0, ANSI/TIA-568.2 and ANSI/TIA-568.3 for Cabling Subsystem 2 and Cabling Subsystem 3.

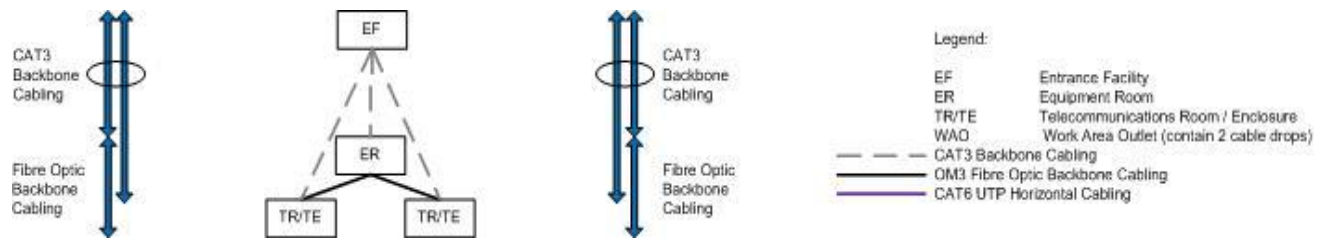
Backbone cabling consists of the multipair copper/fibre cable(s), intermediate and main cross-connect mechanical terminations and patch cords or jumpers used for backbone-to-backbone inter-connection. The cabling should be planned to accommodate future equipment needs, diverse user applications, ongoing maintenance, service changes and relocation.

TOPOLOGY

The backbone cabling shall meet the hierarchical star topology requirements of ANSI/TIA-568.0, unless otherwise specified by this Standard.

There shall be no more than two hierarchical levels of cross-connect in the backbone cabling. From the Horizontal Cross-Connect (HC) or Telecommunications Enclosure/Room (TE/TR), no more than one cross-connect shall be passed through to reach the Main Cross-Connect (MC) or Equipment Room (ER) depending on configuration. Therefore, connections between any two HCs shall pass through three or fewer cross-connect facilities.

NOTE – The topology required by this specification has been selected because of its acceptance and flexibility in meeting a variety of application requirements. The limitation to two levels of cross-connects is imposed to limit signal degradation for passive systems and to simplify moves, adds and changes. This limitation may not be suitable for facilities that have a large number of buildings or those that cover a large geographical area.

*Backbone Cabling Topology*

COMMERCIAL FACILITIES

The incoming fibre cable from the service provider enters the building Entrance Facility (EF) and spliced to ISP fibre at EF if the distance from the EF to the ER exceeds 15m (50ft). The ISP service provider cable runs from EF and terminates at Equipment Room (ER).

The multipair copper cable (if applicable to the project) for centrex voice runs from the ER/TR/TE to EF.

SMALL COMMERCIAL SITES

In small commercial buildings of City of Toronto, there is no ER. The TE/TR acts as an ER. The incoming fibre cable from the service providers enters the facility and spliced to ISP fibre if the distance from the facility entrance to the TE/TR exceeds 15m (50ft). The ISP service provider cable runs from entrance point and terminates at Telecom Enclosure (TE)/Telecom Room (TR)/Equipment Room (ER).

LENGTH

The backbone cable length extends from the termination of the media at the EF (Entrance Facility) to an IC (Equipment Room) or HC (Telecommunications Enclosure/Room). To minimize cabling distances, it is often advantageous to locate the EF near the center of the premises. Cabling installations may be divided into areas, which can be supported by backbone cabling within the scope of this Standard.

Cabling length is dependent upon the application and upon the specific media chosen (see ANSI/TIA-568.0 and the specific application standard). The backbone length includes the backbone cable, patch cords and cross-connect/inter-connect jumpers.

The length of the cross-connect/interconnect jumpers and patch cords in the EF or IC should not exceed 20m (66ft). The length of the cord used to connect telecommunications equipment directly to the EF or IC should not exceed 30m (98ft). For backbone link length less than 150m (492ft), OM4 multimode fibreoptics cable shall be used. More than 150m (492ft), OS2 singlemode fibreoptics cable shall be used.

BACKBONE RECOGNIZED MEDIA

Recognized cables with associated connecting hardware, jumpers, patch cords, and equipment cords shall meet the requirements specified in this document. The recognized media of backbone shall be:

- For Data, the fibre allocation within the fibre optic backbone cable is as follows:
 - 12 Core fibre backbone: Multimode (OM4) and/or Singlemode (OS2) as per backbone cable link length requirements mentioned above
- For Centrex Voice:
 - CAT3/5e multipair U/UTP cabling (if applicable), 25 pair (or higher pair count)

CHOOSING MEDIA

Backbone cabling specified by this Standard is applicable to a wide range of different user requirements. Depending upon the characteristics of the individual application, choices with respect to transmission media have to be made. In making this choice, factors to be considered include:

- Link length [$\leq 150\text{m}$ (492ft) is OM4 multimode, $> 150\text{m}$ (492ft) is OS2 singlemode]
- Useful life of backbone cabling
- Site size, user population and environmental conditions

Each recognized cable has individual characteristics that make it useful in a variety of situations. A single cable type may not satisfy all user requirements. It is then necessary to use more than one media in the backbone cabling. In those instances, the different media shall support the same facility architecture.

CABLING DIRECTLY BETWEEN TELECOMMUNICATIONS ROOMS / TELECOMMUNICATIONS ENCLOSURES

Cabling directly between HCs (Telecommunication Enclosures/Rooms) is not permitted. All backbone cabling must follow the star topology specified in ANSI/TIA-568.0 by connecting back to the IC (Equipment Room/Server Room).

DESIGN CONSIDERATIONS FOR SPACES, ENCLOSURES AND ROOMS

SPACES

- Spaces in commercial premises shall meet the requirements of ANSI/TIA-569-E.
- Spaces shall comply with local codes and regulations.

- Spaces should be designed to be compatible with the worst-case environment to which they will be exposed (see ANSI/TIA-568.0 and TIA/TSB-185 for information on environmental classifications).
- Temperature and humidity shall meet the requirements for Class 4 as per ANSI/TIA-569-E, unless stated otherwise.
- Perform additions and modifications to the existing Local Area Network as shown on the Contract Drawings.

DESIGN GUIDE OF EQUIPMENT ROOM / NETWORK / SERVER ROOM (ER)

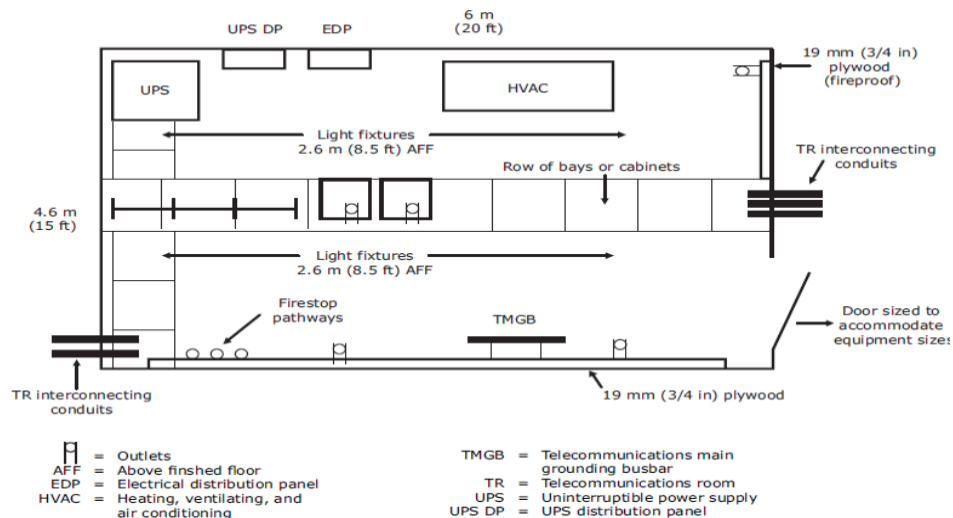
- If designing ER, consult this standard as a reference guide for Equipment Room (ER). Follow architectural/engineering drawings and project specifications as a design guide.
- The ER shall be strategically located to minimize the size and length of the backbone, especially in multiple-backbone situations.
- The ER shall accommodate the delivery of large equipment.
- The doors and hallways shall be sized appropriately for the movement of large equipment.
- Elevator or hoist and loading docks shall be available for large equipment movement.
- The weight capacity of the floors must be rated for large equipment.
- Any potential difficulties in scheduling and use of access routes and facilities for moving large equipment during installation and future changes shall be considered.
- Present and future needs shall be considered in properly locating and designing the ER.
- The ER telecommunications infrastructure shall be sized as required and capable of supporting a broad range of telecommunications applications required by the building or campus.
- Infrastructure shall be present for a large volume of cable between main distribution equipment and server racks.
- The ER telecommunications infrastructure shall be capable of supporting existing telecommunications equipment and/or cabling.
- The length of electrical power feeds from the electrical service entrance to the ER shall be minimized to aid in an optimal bonding and grounding arrangement.
- Access Card Reader should be added to access ER. Refer to CoT CORP SEC Standard for ACR/Sys.

- The distance (no closer than 3m [10ft]) to potential EMI and RFI sources shall be considered. These include transformers, motors, generators, radio transmitters, induction heating devices, photocopier, arc welding equipment, etc.
- The ER shall not be located in any place that may be subject to:
 - Water infiltration
 - Steam infiltration
 - Humidity from nearby water or steam
 - Heat (e.g. direct sunlight)
 - Corrosive atmospheric or adverse environmental conditions
 - Locations below water level unless infiltration preventive measures are employed.
- The ER shall not be located in any space in or adjacent to:
 - Mechanical rooms
 - Washrooms
 - Custodial closets
 - Storage rooms
 - Loading docks
 - Any area that contains sources of excessive EMI, hydraulic equipment, heavy vibration, steam pipes, plumbing, and cleanouts
- The ER must provide space for all planned equipment and access to all equipment for maintenance, administration and growth.
- The ER must meet the space requirements specified by equipment providers. Space and layout requirements for different telecommunications applications (e.g. voice, data) must be taken into account.
- For voice and data, provide 0.07m² (0.75ft²) of ER space for every 10m² (100ft²) of usable work area space.
- The minimum ER size shall be based on the known number of work areas as shown on the table below and not on usable floor area:

Equipment outlets served	Minimum floor space m ² (ft ²)	Typical dimensions m (ft)
Up to 100	9 (100)	3 X 3 (10 X 10)
101 to 200	13.5 (150)	3 X 4.5 (10 X 15)
201 to 800	36 (400)	6 X 6 (20 X 20)
801 to 1600	72 (800)	6 X 12 (20 X 40)
1601 to 2400	108 (1200)	9 X 12 (30 X 40)

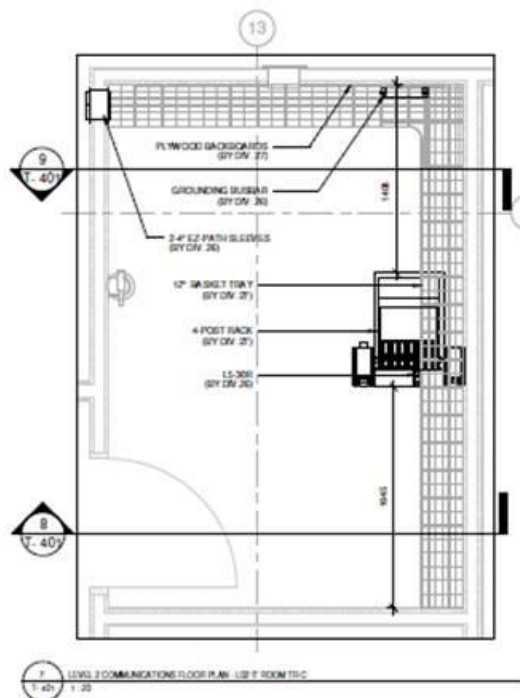
- The guidelines for other support equipment, such as power distribution, conditioner systems, and UPS up to 100kVA shall be permitted in the ER. UPS larger than 100kVA should be located in a separate room.
- The ER layout and floor plan shall comply with TIA-568, TIA-569 and BICSI TDMM latest edition.
- A minimum ER space of 3m (10ft) by 4.5m (15ft) shall be allocated.
- The ER shall include adequate space to support equipment changes with minimal disruption. Sizing shall include projected future as well as present requirements.
- Equipment not related to the support of the ER (e.g. piping, ductwork, pneumatic tubing, etc.) shall not be installed within, pass through, or enter the ER.

Typical equipment room layout



- The ER shall include space for environmental control equipment, power distribution/conditioners, and uninterruptible power supply (UPS) systems that may be installed.
- The ER shall be designed and comply with the City of Toronto (CoT) Security requirements.

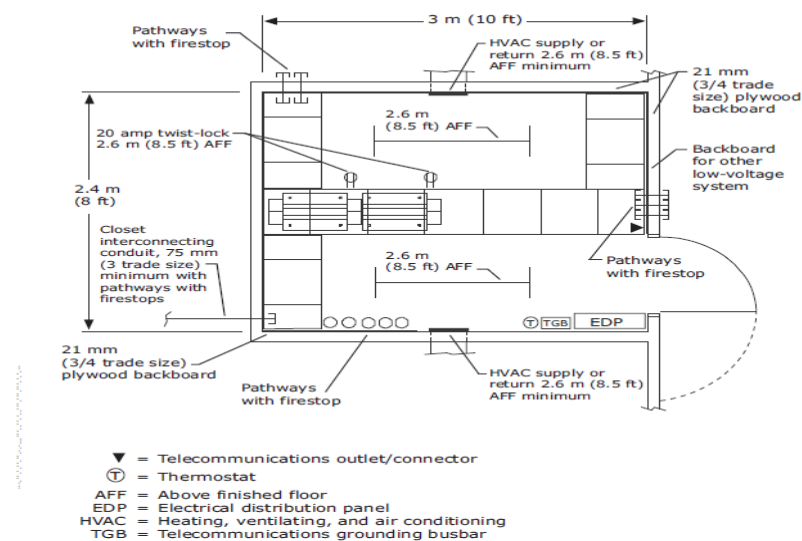
- The ER shall include barriers to protect sensitive network equipment from dust including door seals and air filtration.
- The ER shall include equipment and systems (grounding straps) to protect sensitive network equipment from static electricity.
- The ER shall be designed to comply with local zoning requirements for earthquakes and other natural disasters.
- The ER shall be designed to comply with NFPA-75 and include a pre-action fire protection system and hand-held fire extinguishers.
- The ER shall be designed for flood prevention and include a minimum of one floor drain for every 100m² (1075.84ft²).
- The ER shall attenuate ambient room noise to acceptable Acoustic Noise level limits in accordance with applicable standards.
- There shall be no attachment of pull boxes or any type of panel/enclosure onto the surface of the Telecom Enclosure/Cabinet/Rack. It is strictly prohibited and shall not be allowed in any circumstances to have a box or enclosure attached/fixed on the surface of a Telecom Enclosure/Cabinet/Rack.

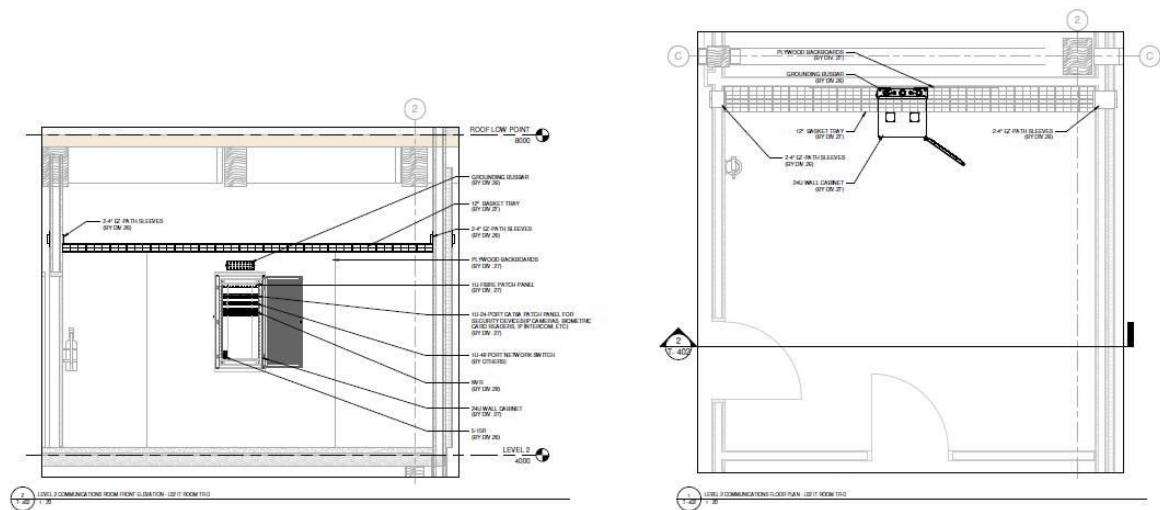


DESIGN GUIDE OF TELECOMMUNICATIONS ROOM (TR)

- If designing TR, consult this standard as a reference guide for Telecommunications Room (TR). Follow architectural/engineering drawings and project specifications as a design guide.
- A properly designed TR includes an HC (FD) that provides a floor-serving distribution facility for horizontal cabling. This cross-connect is capable of providing horizontal cabling connections to floor-serving telecommunications equipment and backbone cables from other TRs|TEs|ERs|EFs.
- Access Card Reader should be added to access ER. Refer to CoT CORP SEC Standard for ACR/Sys.
- The TR should be provisioned to house telecommunications equipment. In some cases, it may be necessary to combine the building and floor-serving functions of the ER and TR in one room. Instances where the two may be combined include smaller buildings (i.e., less than 500 m² [5400 ft²]) and those with limited space for distribution facilities.
- There must be at least one TR per floor. Multiple rooms are required if the cable length between the HC (FD) and the telecommunications outlet location, including slack, exceeds 90m (295ft) or if the usable floor space to be served exceeds 929m² (10,000ft²). For TRs that serve areas with an office density of less than one work area per 9.3m² (100ft²) of usable floor space, a TR may serve larger areas, provided the horizontal cable length requirements are met.
- Figure below shows a typical layout of a full-size TR, suitable for a maximum of 480, 4 twisted-pair cable terminations. The drawing illustrates architectural, mechanical, electrical, and telecommunications requirements on a single plan view perspective for purposes of showing coordination issues. Actual design documents will typically separate requirements by discipline.

Typical telecommunications room layout





ENTRANCE FACILITY REQUIREMENTS (EF) | SHARED LAN/NETWORK ROOMS

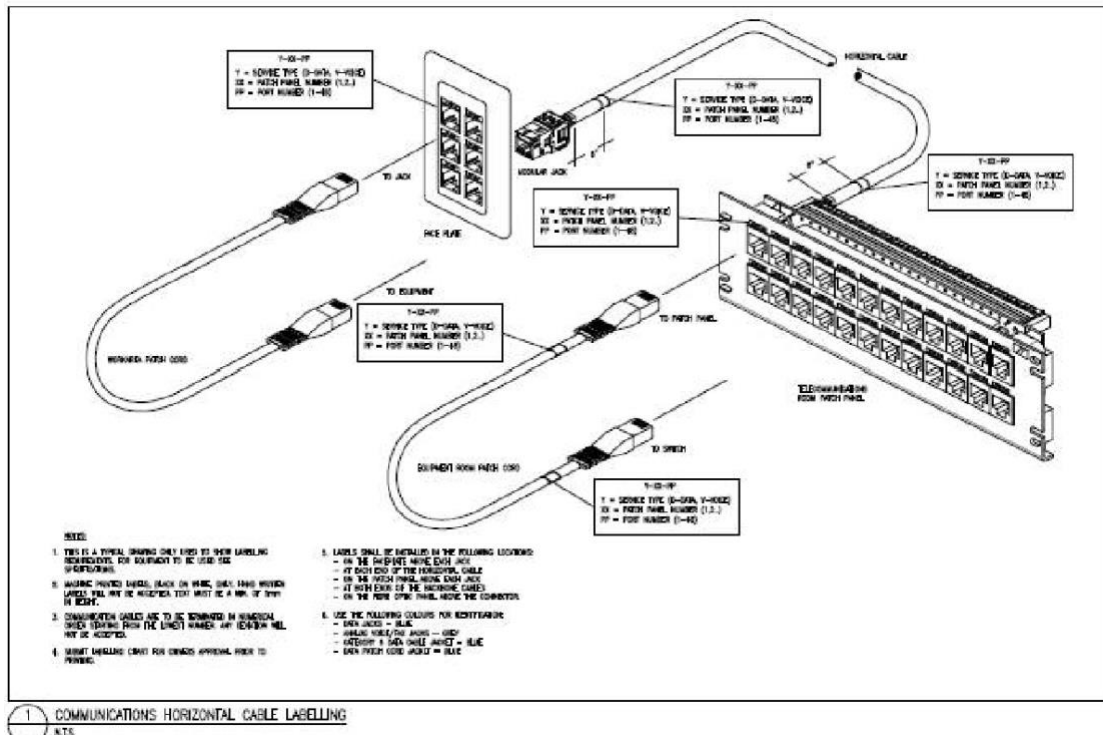
- If designing EF, follow architectural/engineering drawings and project specifications as a design guide.
- Where functions of an entrance facility (EF) are combined with functions of the ER in the same space, the ER may house equipment dedicated to the Access Provider (AP). Requirements specified by the AP must be considered.

WORK AREA OUTLET (WAO)

- The work area outlet (WAO) components extend from the telecommunications outlet/connector end of the horizontal cabling system to the work area equipment. The telecommunications outlet/connector shall meet the requirements of this Standard. To simplify relocations, consider a single style of outlet/connector for all work area outlets of the same media type.

WORK AREA OUTLET (WAO) FOR OFFICE AREAS

- Provide one 4-ports, single-gang, work area outlet in each work area for termination of the horizontal CAT6/6A cables. Faceplate or decora module frame shall be from Belden.
- One 4-port, work-area outlet shall be associated with as many ports necessary (in groups of 2 or 4) on the snap-in faceplate installed in the patch panel of the Telecommunication Enclosure.
- In the majority of cases the 4-port, work-area outlet shall be installed within the cubical partitions. In some situations, the work-area outlet shall be installed directly on the wall in office areas.
- All UTP connectors in the office area shall be unshielded modular jacks and wired for a T586A wire-map.



U/UTP PATCH CORD FOR WAO IN OFFICE AREAS

- Patch cords used in the WAO shall meet the requirements of ANSI/TIA-568.2. WAO cabling may vary in form depending on the application. When application-specific adaptations are needed at the WAO, it shall be external to the telecommunications outlet/connector.
- Supply two (2) 5-metres or less, CAT6/6A U/UTP patch cords for each work area outlet.
- The contractor is responsible for certifying that the supplied patch cords shall meet or exceed the requirements for U/UTP patch cords as described in the ANSI/TIA-568.0 standard.

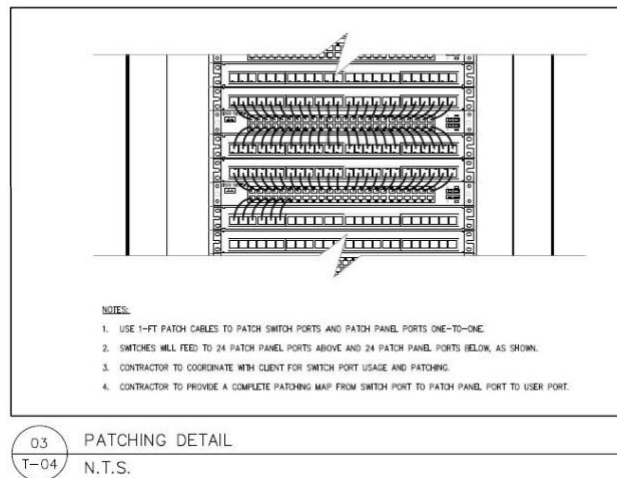
WORK AREA OUTLET (WAO) FOR WIRELESS ACCESS POINT (WAP)

- Provide one (1) 4-port, single-gang, work-area outlet, connectors and accessories for termination of the horizontal UTP cables (2 for each WAP) dedicated for Wireless Access Point (WAP). Where ever, it is possible to connect to the closest TR, additional and separate WAO may not be required.
- CAT6/6A modular jacks shall populate two (2) modules/jacks in a 4-port WAO for each WAP.
- Each 4-port, work-area outlet shall be associated with a 4-port, snap-in faceplate installed in the Telecommunication Enclosure patch panel.

- WAP Heatmaps are required for accurate location of WAOs. Sample heatmaps are in Appx-C.

UTP PATCH CORD FOR TE/TR/ER

- Supply minimum of 0.5 metre (2ft) CAT6/6A U/UTP patch cord for each data/VoIP drop (jack/module) to patch at TE/TR/ER.



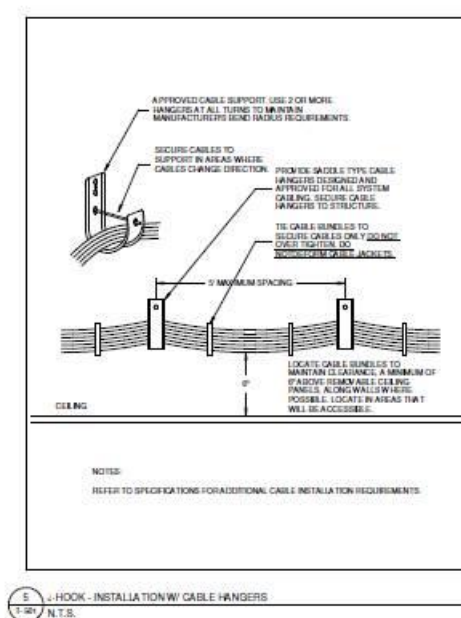
DESIGN CONSIDERATION OF PATHWAYS AND CONTAINMENT SYSTEM

- Pathways in commercial premises shall meet the requirements of latest ANSI/TIA-569 standard.
- Pathways should be designed to be compatible with the worst-case environment to which they will be exposed (see ANSI/TIA-568.0 for information on environmental classifications).
- Pathways in commercial premises shall comply with local codes and regulations.

DESIGN GUIDE OF CABLE TRAY SYSTEM

- All cable trays shall be either a ventilated trough, wire-mesh or ladder-rack type, pre-fabricated structure 300mm (12 inches) in width or greater.
- Ventilating trays shall be equipped with two side rails with a maximum height of 150mm (6 inches) and consisting of a light, rugged and tubular steel or aluminum construction.
- Should aluminum trays be specified (CoT approval is mandatory), the engineer is to ensure that, during the grounding or bonding aspects of the installation, the contractor uses tin plated or zinc coated ground connectors.

- Install the ventilated cable tray in the horizontal cable distribution system such as hallways and under floor.
- A cable ladder rack system is to be installed within the Equipment/Server Room (ER) and Telecom Rooms (TR). Refer to the project specifications/drawings or reference in this document for the type of ladder rack to be used in the horizontal cable distribution system and within the applicable ER/TR's. Spine type and improperly centre hung cable trays will not be accepted.
- All metal cable trays shall be bonded together to the TMGB/PBB or a TGB/SBB.
- All metal cable trays shall be coated to prevent rust or galvanic action.
- Accessories and fittings such as elbows and reducers shall be manufactured by the cable tray manufacturer.
- Install cable trays at least 300mm (12in) away from fluorescent luminaries and cross power cables at right angles.
- The minimum clearances for cable trays shall be in accordance with Canadian Electrical Code C22.1-09.
- Allow 300mm (12in) vertical clearance excluding the depth of cable trays, between cable trays installed in tiers.
- 300mm (12in) vertical clearance from the top of cable trays to all ceilings, heating ducts and heating equipment.
- 600mm (24in) horizontal clearance on one side of cable tray mounted adjacent to one another or to walls or other obstructions.
- All cable trays/ladders shall be labeled at regular intervals. The distance separating labels shall not exceed 15 metres (50ft).
- The design fill ratio of a cable tray is 25% to a maximum fill ratio of 50% as per ANSI/TIA-569 standard.



- The inside radius of a bend in a conduit shall be not less than six times the internal diameter when the conduit is less than 50mm (2in) in diameter and ten times the internal diameter when conduit is 50mm (2in) in diameter or larger.
- All zone conduits shall be identified and labeled at both ends and at regular intervals not to exceed 10 metres (32.8ft). Tags shall identify start and finish of conduit runs. Pull boxes shall be labeled on the exposed exterior.
- All conduits shall originate and be physically connected to the telecom backboards in the Equipment Room, Telecommunications Room, cable tray and pull box.
- All metallic parts of the cable distribution supporting system shall be bonded together mechanically inclusive of all transition points (i.e. cable tray and distribution conduit not mechanically connected) using a 6 AWG green jacketed stranded copper ground wire. The metallic components of the cable distribution system shall be bonded together at the ER and TRs and then bonded to their respective telecom ground busbars.
- All fittings, connectors and couplings shall be of the same material as the conduit used on site.
- All conduits/sleeves that enter the ER or any TR shall be fitted with an approved ground bushing with ground lug and bonded together mechanically (one continuous piece preferred). This shall be connected to the approved building ground by means of a No. 6 AWG to the grounding busbar.

- Cable fill capacities of conduit shall not be greater than 40%.
- All conduits entering or existing through the ceiling or walls of the ER or TR shall protrude into the room 25-50mm (1-2in).
- Riser sleeves in the Equipment Room/Server Room and Telecommunication Rooms shall protrude through the floor 50-75mm (2-3in) above finished floor (AFF).
- All conduit runs shall follow building grid lines and shall be concealed where possible.
- All conduits shall be EMT, reamed and bushed at both ends and bonded to the distribution system unless installed in areas deemed chemically hazardous in which cases PVC coated or Aluminum conduit shall be used. Approval from the City of Toronto is required in such instances.
- All conduit runs shall be a maximum of 30 meters (100ft) in length with a maximum of two 90 degree bends between pull points, unless otherwise specified.
- Conduits ending in the vicinity of a cable tray shall be terminated at a height of no less than 100mm (4in) and no more than 150mm (6in) from the top of the cable tray. Conduit runs shall not be punched through the side of the tray. Conduit ends shall be bonded to the cable tray.
- The use of LB, LL, LR, C and T type fittings are not permitted. Only LBs designed and manufactured for communications systems are allowed where applicable.
- Conduit fittings shall not be used in place of pull boxes or bends.

DESIGN GUIDE OF PULL BOX

- A pull box shall be placed in conduit runs where the sum of the bends exceeds 180 degrees, where the overall length of the conduit run is more than 30m (100ft), or if there is a reverse bend in the run.
- Pull boxes shall be constructed and sized in accordance with Canadian Electrical Code, TIA and BICSI standards of code gauge steel and shall have a rust resistant finish.
- In all instances pull boxes shall be placed in straight sections of conduit run and shall not be used in lieu of a bend. Corresponding ends of the conduit are to be aligned with each other. Conduit fittings shall not be used in place of pull boxes or bends.
- Conduit must enter the outlet boxes from the top or bottom.
- Pull boxes shall be installed at a reasonable height, in an exposed location and such that access for installation of cables is not prohibited. Pull boxes shall not be placed in a fixed false ceiling

space, unless immediately above a suitably marked and hinged access panel. Provide indicator decals on ceiling T-bar rail or ceiling tiles showing location of pull box or splice box.

- All conduits shall be installed in accordance with Canadian Electrical Code, Part 1 Section 12, applicable building codes and ANSI/TIA 569.
- The minimum size (inside diameter) for conduit running between the Equipment Room or a Telecommunications Room and the Telecommunications outlet at an outlet location is 25mm (1in).
- The maximum horizontal cable run distance shall not exceed 90 metres (295ft).
- The cable length from the mechanical termination in the TR and ER to the telecommunications outlet, where the horizontal distance exceeds 90m (295') provided additional rooms as required.
- Future requirements for additional cables to each outlet shall be considered.
- A pull cord shall be installed in all conduits.
- The telecommunications outlet conduit system shall be labeled green.
- Place pull boxes in readily accessible locations only.
- The use of LB, LL, LR, C and T type fittings are not permitted. Only LBs designed and manufactured for communications systems are allowed where applicable.
- There shall be no attachment of pull boxes or any type of panel/enclosure onto the surface of the Telecom Enclosure/Cabinet/Rack. It is strictly prohibited and shall not be allowed in any circumstances to have a box or enclosure attached/fixed on the surface of a Telecom Enclosure/Cabinet/Rack.

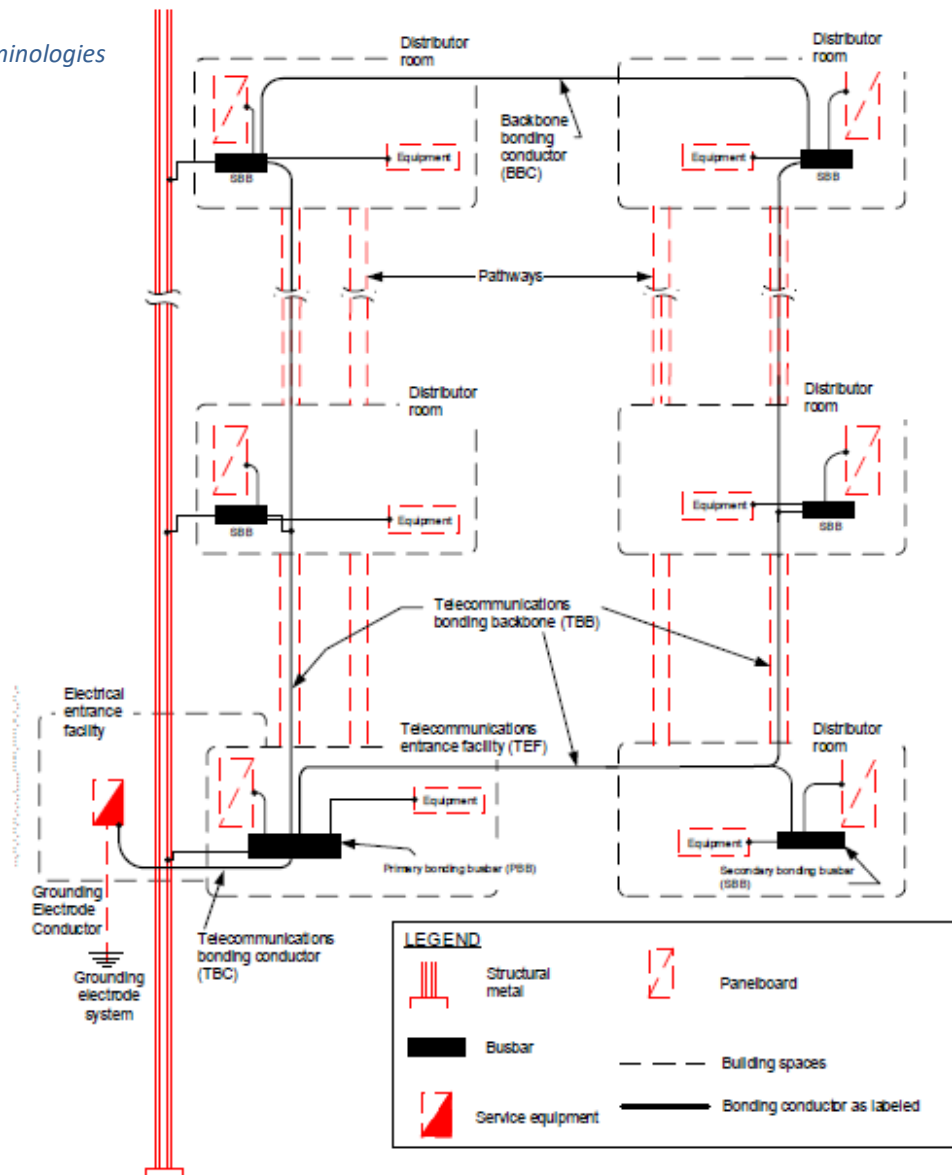
DESIGN GUIDE OF TELECOMMUNICATIONS BONDING AND GROUNDING SYSTEM

In general, a telecommunications grounding system contains the following components:

- Primary Bonding Busbar (PBB) or Telecommunications Main Grounding Busbar (TMGB)
- Telecommunications Bonding Backbone (TBB)
- Secondary Bonding Busbar (SBB) or Telecommunications Grounding Busbar (TGB)
- Telecommunications Bonding Conductor (TBC)

- The Telecommunications Bonding Backbone (TBB) consists of green jacketed stranded copper conductors and insulated copper busbars. The system extends from the Building Grounding Electrode Conductor through the ER to the TR's, within the building. The construction of the TBB is a requirement of the latest version of the ANSI/TIA-607. This standard shall be used in the design, installation, management and administration of the TBB systems in CoT facilities.

TIA--607-Terminologies



- All metallic parts shall be bonded together mechanically and attached to the approved building ground in accordance with applicable CEC, TIA and CSA standards. In all cases, the CEC shall be met or exceeded.

- Bonding conductors shall be continuous and routed in the shortest possible straight-line path. Any bends placed in the conductor shall be sweeping bends.
- Aluminium wires, clamps or terminal connectors are not acceptable for grounding and bonding.
- The following general requirements shall apply when constructing the TBB system:
 - An insulated pre-drilled, electro tin plated copper busbar, minimum dimensions of 6mm thick x 100mm wide and variable in length, shall be installed on the wall of the ER/EF adjacent to the cable entrance conduits, 150mm from the corner of the ER/EF and 150mm AFF. This busbar is known as the Primary Bonding Busbar (PBB) or Telecommunications Main Grounding Busbar (TMGB) and shall be insulated from its support by a minimum of 50mm.
 - An insulated pre-drilled, electro tin plated copper busbar, minimum dimensions of 6mm thick x 50mm wide and variable in length shall be installed on the wall of each TR (formally known as a Telecom Closet - TC), adjacent to the cable entrance sleeves, 150mm from the corner of the TR and 300mm AFF. These busbars are known as the Secondary Bonding Busbar (SBB) or Telecommunications Grounding Busbars (TGBs) and shall be insulated from its support by a minimum of 50mm.
 - A green jacketed stranded copper ground wire sized to maintain a voltage drop of less than 40 Volts under maximum short time rating. This wire shall be sized no smaller than No. 6 AWG nor larger than a 3/0 and shall be installed from the service equipment ground (main building ground) to the PBB/TMGB in the ER/EF. This ground wire is known as the Telecommunications Bonding Conductor (TBC). The Telecommunications Bonding Conductor (TBC) may be secured to the surface of the building if not subject to physical and mechanical damage, or installed in non-ferrous conduit. If ferrous conduit, such as EMT is used, the conductors shall be bonded to each end of the conduit with a conductor minimum sized as a No. 6 AWG green jacketed stranded copper ground wire.
 - The TBC shall be connected to the Primary Bonding Busbar (PBB)/Telecommunications Main Grounding Busbar (TMGB). The connection to the PBB/TMGB shall be done using a 2-hole electro tin plated compression lug. All joints to the TBC shall be done using irreversible compression-type connectors, exothermic welding, or equivalent.
 - The Telecommunications Bonding Conductor (TBC) shall be connected to the service equipment ground (main building ground) by qualified personnel and in accordance with the CEC and ANSI/TIA-607.
 - A green jacketed stranded copper ground wire sized the same as the Bonding Conductor for Telecommunications, shall be installed from the farthest TR, through each TR to the

Bonding Conductor for Telecommunications located in the ER/EF. This ground wire is known as the Telecommunications Bonding Backbone (TBB). The TBB may be fastened to the underside of open cable tray or installed in non-ferrous conduit. If ferrous conduit, such as EMT is used, the conductors shall be bonded to each end of the conduit with a conductor sized as a No. 6 AWG minimum.

- The TBB in each TR shall be connected to the SBB/TGB. All joints to the grounding wires shall be done using irreversible compression-type connectors, exothermic welding, or equivalent. The connection to the SBB/TGB shall be done using 2-hole compression connectors.
- The PBB/TMGB in the ER/EF and the SBB/TGB in the TR/TE(s) shall be bonded to the closest electrical panel using a No. 6 AWG green jacketed stranded copper ground wire.
- The metallic components of the horizontal distribution supporting infrastructure (conduits, cable trays and ducts) shall be bonded to the telecommunications busbars of the ER/EF or TR/TE in which they originate using a No. 6 AWG green jacketed stranded copper ground wire.
- A No. 6 AWG green-jacketed stranded copper ground wire shall be installed from each telecommunications busbar to the metal frame (structural steel) of buildings that are effectively grounded and whose structural steel is accessible.

SEPARATIONS FROM EMI

- Copper cables shall not be installed at a distance less than 300mm from lighting ballasts, less than 1 meter from electric motors or at a separation distance from source of 480V or less.
- Where electric power cable is not installed in EMT conduit, telecommunications cable shall not be run in parallel with it for more than 10 meters if the separation is less than 300mm.
- Electrical protection must be provided for copper cables entering the building. Protection shall be in accordance with the Canadian Electrical Code CSA C22.1-2006 and BICSI practices.

DESIGN GUIDE OF TAGGING CONVENTION (IDENTIFICATION AND LABELING)

- The requirements of this section shall take precedence over other sections.
- The labeling of the City of Toronto network components, structured cabling and cable routing/containment shall comply with the ANSI/TIA-606 standard

- The codification of network components, cables and cable routing shall follow the identification standards detailed in this standard.

- For example:

- Building Location: YDE – 30 Dee Ave

- Floor and Room Location: ER – Equipment Room / Server Room / Main Communications Room

TRA – Telecom Room - A

TRB – Telecom Room – B

EF - Entrance Facility

- Service Provider / Network Cabinet Label in ER: COT-IT-YDE-0100

Network Closet

- Network Cabinet Label in ER: COT-IT-YDE-0200

Network Closet

- Server Cabinet Label in ER: COT-IT-YDE-0300

Server Closet

- Patch Panel: A – Data Patch Panel A (A,B,C, etc ...)

FP01 – Fibre Optic Patch Panel

TP01 – Telephone/Voice Patch Panel

- Patch Panel Port: 01 – Patch Panel Port (01, 02, 03, ..., 24)

- Work Area Number: 125 – Work Area number associated in the admin/office areas of the facility

- Work Area Outlet: WA01 – Work area outlet (01, 02, 03, etc...)

1 – Port number (1, 2, 3, 4)

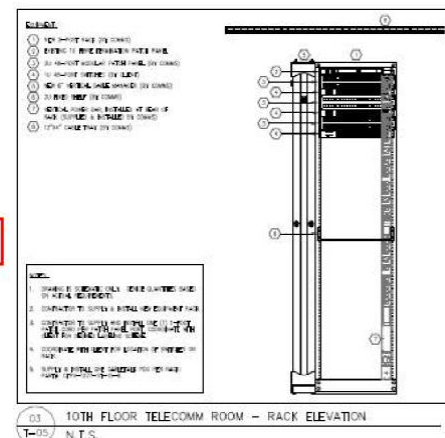
EQUIPMENT / NETWORK / SERVER ROOM CABINETS IDENTIFICATION AND LABELING

- Equipment Room/Server Room network enclosure contains active network components, including: Network Core Closet, Server Closet and Telecommunications Enclosure.
- All Network Closets/Cabinets related to the Equipment Room (ER) shall be tagged as follows.

- COT-IT-XYZ-XX00, where:
 - XYZ = Site three-character code name
 - XX00 = First two numbers (XX) identify the closet
- For all closets/enclosures/cabinets in the Equipment Room, the last two numbers are always zero (00).
- For Closets/Cabinets in the Equipment Room, they are numbered from (0100) to (1000).
- Network Core Closet and Server Closet nameplate shall conform as follows:
 - Provide nameplate for each enclosure on the bottom-center of the door, front and back.
 - Use engraved gravoply laminate nameplates using black letters on a white background.
 - The laminate nameplates shall have a dimension of 210mm W x 50mm H.
 - Minimum character height shall be 12mm. Character lettering shall be centered on each line.
 - Mount nameplates with two stainless steel machine screws.
 - Include device identification (tag) number as well as a descriptive name.
 - For example: the tag name: COT-IT-XYZ-0100 followed by the description: Sample nameplate diagram is as below:

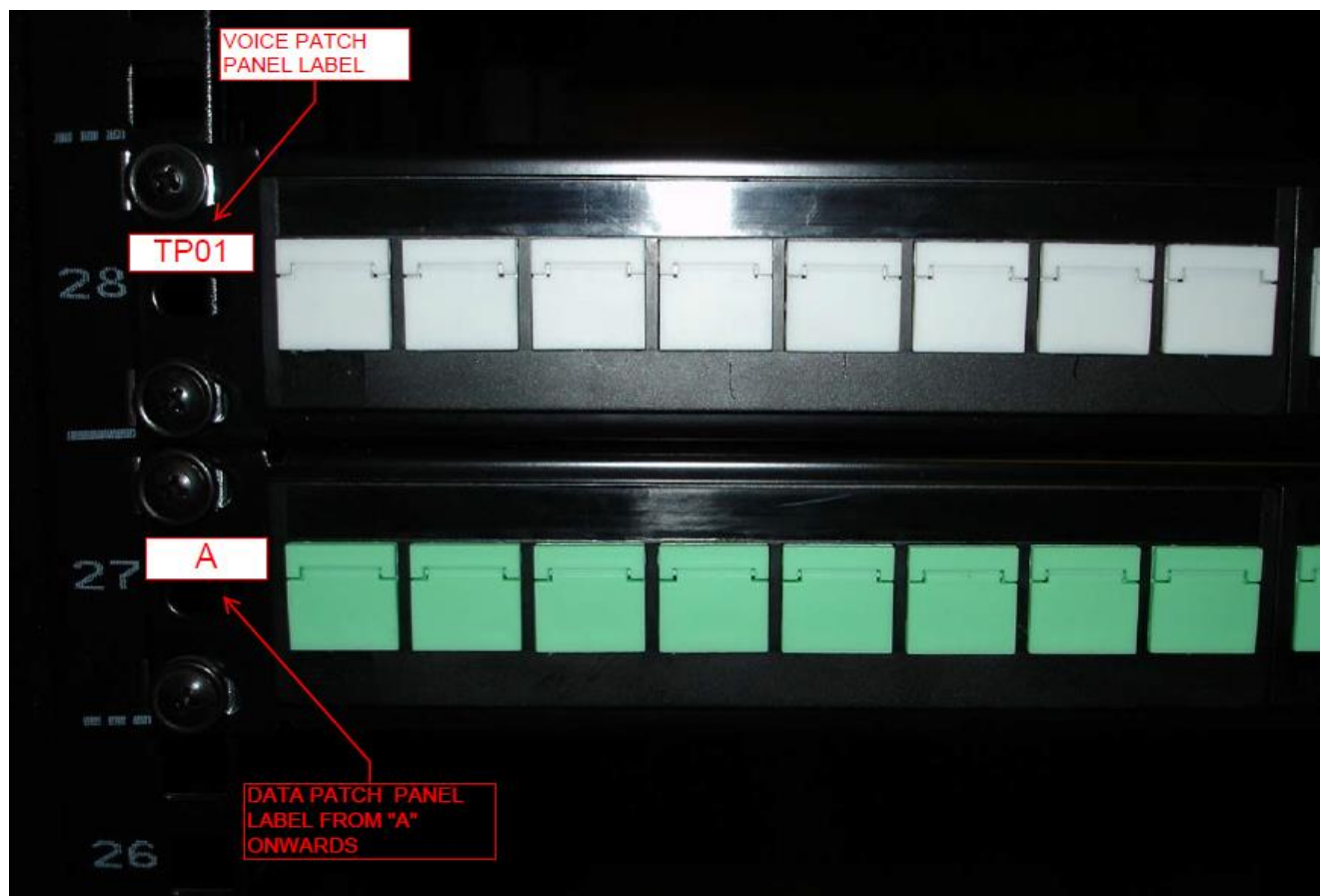


COT-IT-YDE-0100
NETWORK CLOSET
(Lamacoid label on
the cabinet shall be
at the bottom. IT
will provide lamacoid
spec standard)

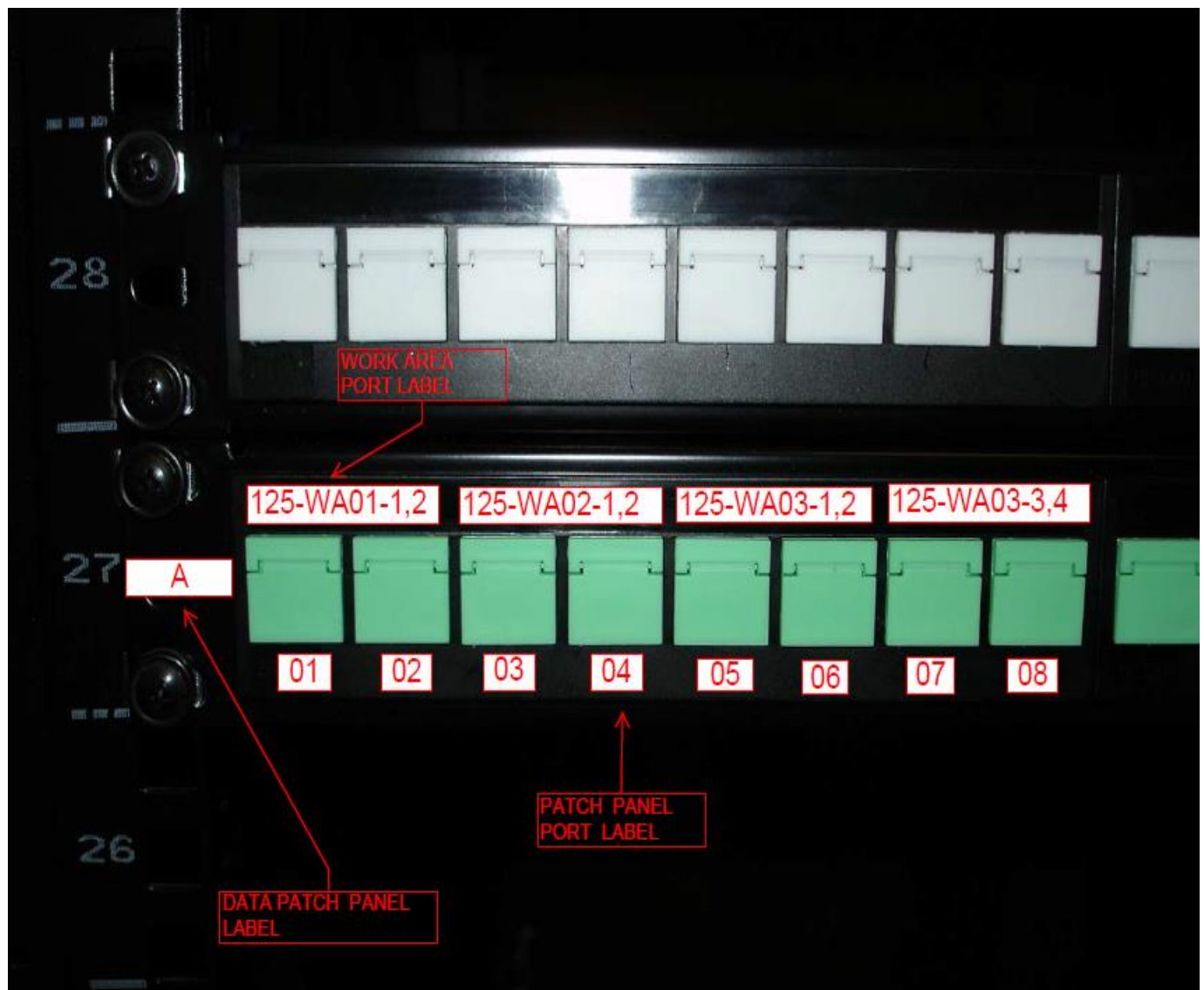


COPPER PATCH PANEL (CP) & WORK AREA OUTLET (WA) IDENTIFICATION AND LABELING

- The copper data patch panels in a Telecommunications Enclosure/Closet shall employ one character A, B, C, ..., Z. The rack shall be populated with patch panel(s) as necessary and labeled in sequential order from top to bottom.
- For example, the first copper data patch panel from the top of the rack shall be labeled A, the second shall be B, and so on.
- Each 24-port patch panel shall have six (6) snap-in faceplates that group four terminations. For office areas, the minimum number of ports associated with a work area outlet shall be a group of two (2) ports.
- Labels shall be applied to patch panels in such a manner as to be readily visible and not obscured by structured cabling or patch cords.



- Labels for each 4-port or 2-port, snap-in faceplate shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels shall not be accepted.
- Lettering shall be black on a white background. Characters are a minimum of 4mm high.
- Apply a label on the top of each group of 4-ports or 2-ports on the snap-in faceplate to indicate the destination of the cables terminated on the data ports (RJ).
- For office areas, the label 125-WA01 would be applied on the patch panel for a group of 2 ports with destination cables to work area outlet 125-WA01. Whereas, 125 represents the room number of the facility and WA01 represents the work area 01.



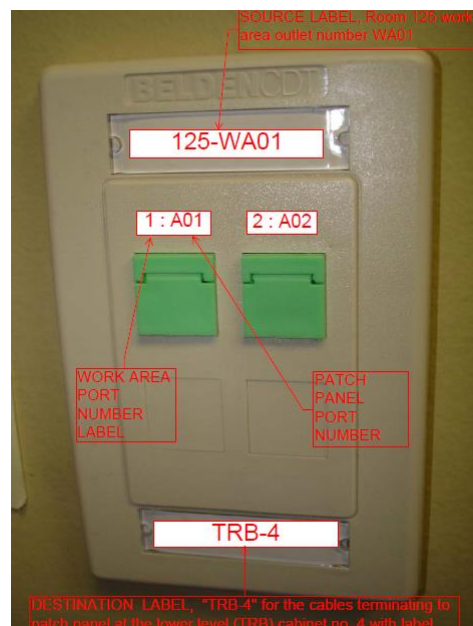
- Apply a two-digit label immediately above each data port (RJ) indicating its destination port number on the work area outlet. For example, a group of four consecutive ports on a 24-port patch panel whose destination is port numbers 1 to 4 on a WAO would have the ports labeled 1, 2, 3, 4. Provide color-coded, snap-in icons for each data port (RJ).

FIBREOPTICS PATCH PANEL (FPP) IDENTIFICATION AND LABELING

- Lettering shall be black on a white background. Characters are a minimum of 4mm high.
- Terminate all 12 fibres of each fibre optic cable in Fibre Enclosures (Telecommunications Enclosure or Network Core Closet).
- The fibre cable for all even-numbered Telecommunications Enclosures shall terminate at Network Core Closet 02 (XYZ-0200) while odd-numbered shall terminate at Network Core Closet 01 (XYZ-0100).
 - For cases where Network Core Closet 01 and Network Core Closet 02 are located in different Equipment Rooms, Telecommunications Rooms / Telecommunications Enclosures shall have fibre terminating in both Network Core Closets.
- The ordering and color of individual fibres shall be the same for each fibre cable and compliant with the latest ANSI/TIA-568.3 and ANSI/TIA-598 standards.
- Labels for patch panels shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels shall not be accepted.
- Labels shall be applied to patch panels in such a manner as to be readily visible and not obscured by structured cabling or patch cords.
- A label shall be applied to the top of the LC duplex adapter modules associated with a single fibre cable indicating the destination of the cable.
- For example, the adapter modules that terminate the fibre cable whose destination is Telecommunications Enclosure 1400 would be labeled as XYZ-1400.
- The fibre patch panel label shall be labeled as follows FPXX where XX is the fibre patch panel sequence i.e. 01, 02, 03...etc. The rack shall be populated with patch panels as necessary and labeled in sequential order from top to bottom.
- For example, the first patch panel from the top of the rack would be labeled as FP01, the second is FP02 and so on.

WORK AREA OUTLET (WAO) IDENTIFICATION AND LABELING

- Labels for each 4-port, work area outlet shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels shall not be accepted.
- Lettering shall be black on a white background. Characters shall be a minimum of 4mm high.
- A label shall be applied to the top of each 4-port, work-area outlet indicating the source of the Horizontal cables.
- For example, WAO port 1 connected to patch panel A port 1 would be labelled as A01. WAO port 2 to patch panel A port 2 is labelled A02 and so on.



CABLE IDENTIFICATION AND LABELING

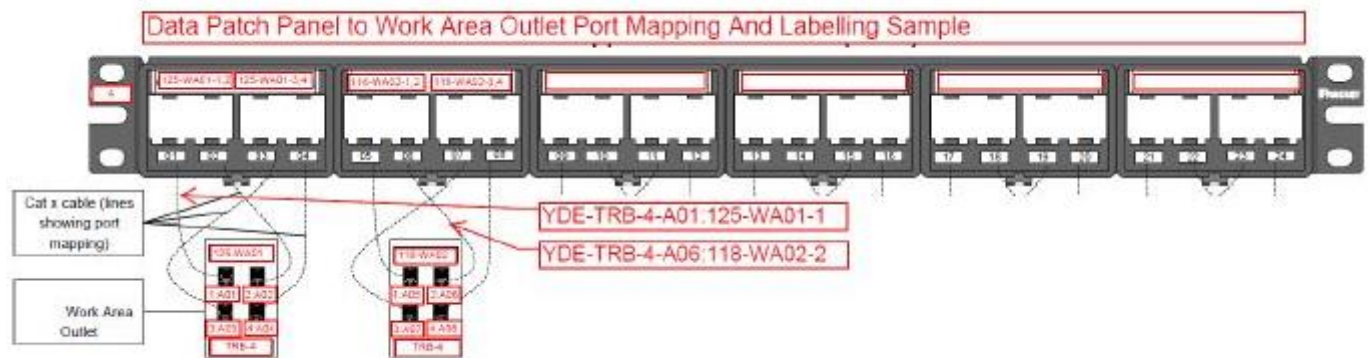
- Use durable non-fading sleeve type wire markers to identify all network cables.
- Labels for cabling shall be laser printed, self-laminating, adhesive, polyester (indoor/outdoor). Hand-written labels will not be accepted.
- Lettering shall be black on a white background. Characters shall be a minimum of 4mm in height.

FIBREOPTICS BACKBONE CABLE IDENTIFICATION AND LABELING

- As a minimum, all fibre optic backbone cables shall be labeled at both ends of the cable, within every pull box and every 15 metres.
- In addition, the fibre backbone cables shall be labeled at each transition. A transition is defined as: a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
- If the fibre cable is run in conduit then the transition labels shall be applied to the conduit.
- The tagging convention for identification of fibre optic backbone cables shall indicate the source and destination of the cable separated by a colon.
- For example, a fibre optic backbone cable whose source is Network Core Closet 2 (XYZ-0200), Fibre Patch Panel 01, adapter panel A and terminates in Telecommunications Enclosure 1400 (XYZ-1400) on the fibre patch panel 01 adapter panel A would have the following tag: 0200-FP01-A.01: 1400-FP01-A.01. The last "01" digits represent fibre strands.
- The Telecommunications Enclosure fibre optic patch panel must be labeled. For example: Telecommunication Enclosure 1400 with two fibre optic patch panels would be labeled "FP01" and "FP02", where "FP01" is the first patch panel from the top.

HORIZONTAL COPPER CABLE IDENTIFICATION AND LABELING

- As a minimum, all horizontal CAT6/CAT6A cables shall be labeled at both ends of the cable, within every pull box and every 15 metres.
- In addition, the cables shall be labeled at each transition. A transition is defined as: a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
- If the cable is run in conduit then the transition labels shall be applied to the conduit.
- The tagging convention for identification of Horizontal cables shall indicate the source and destination of the cable separated by a colon.
- Example 1: a horizontal cable whose source is Telecommunications Enclosure TRB-4, Patch Panel A, port 01 and whose destination is port 1, Work-Area Outlet 01, in room number 125 would have the following tag: YDE-TRB-4-A01:125-WA01-1.



VOICE BACKBONE COPPER CABLE IDENTIFICATION AND LABELING

- As a minimum, all voice backbone cables shall be labeled at both ends of the cable, within every pull box and every 15 metres.
- In addition, the voice backbone cables shall be labeled at each transition. A transition is defined as - a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
- If the voice cable is run in conduit then the transition labels shall be applied to the conduit.
- The tagging convention for identification of voice cables between the voice block and the Telecom Closet/Enclosure patch panel in the building shall be VFFA-CC : XYZ-A-TP01 (indicate the source and destination of the cable separated by a colon), where V indicates voice, FF indicates the floor number, EF indicates telecommunications entrance facility ID, CC indicates 2-digit voice cable number, and XYZ-A is telecommunications closet/enclosure ID.
 - For example, voice cable 01 whose source is entrance room EF and terminates in Telecommunications Room B (YDE-TRB) on patch panel TP01 would have the following tag: V01EF-01 : YDE-TRB-TP01.

PATCH CORD IDENTIFICATION AND LABELING

- As a minimum, all Contractor installed CAT6/CAT6A or fibre optic patch cords shall be labeled at both ends of the cable.
- The tagging convention for identification of patch cords shall indicate the source and destination of the cable separated by a colon. The source is the switch port and the destination is the patch panel, termination point.

CABLE PATHWAYS IDENTIFICATION AND LABELING

- All ducting (cable tray or conduit) carrying fibre optic and multi-pair voice backbone cables shall be tagged as "LAN BACKBONE ".
- All ducting (cable tray or conduit) carrying Horizontal cables shall be tagged as "LAN HORIZONTAL" with the source and destination network panels.
- All ducting shall be labeled at each transition. A transition is defined as - a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
- Use engraved gravoply laminate nameplates using black letters on white background.
- The laminate nameplates shall have a dimension of 210mm W x 50mm H.
- Minimum character height shall be 12mm. Character lettering shall be centered on each line.

FIRE STOPPING

- Fire stop systems in commercial premises shall meet the requirements of latest ANSI/TIA-569.
- Fire stop systems should be designed to be compatible with the worst-case environment to which they will be exposed (refer to ANSI/TIA-568.0 for information on environmental classifications).
- Provide EZ PATH solution where conduit penetrates fire rated walls, floors, partitions and ceilings to ensure that the fire rating is maintained. Abandoned penetrations shall be properly fire stopped. Provide EZ PATH system.
- The required fire rating is minimum 2 hours.

SUBMITTALS

- Comply with the requirements of Section 01300 - Submittals.
- Shop Drawings shall be submitted to the City of Toronto IT staff for final review before proceeding with any works.

- The shop drawings and all submissions shall be reviewed and sealed by the RCDD Contractor's PM and re-reviewed and sealed by the Consultant's RCDD before reaching the City for final review.
- Final design drawings/construction drawings shall be submitted to the City of Toronto IT staff for final review and before proceeding with any works. These drawings shall be reviewed by PM RCDD Contractor and re-reviewed and approved by RCDD Consultant before reaching to the City for final review.
- The CADD drawings shall meet the City's CADD standards. Any non-compliance shall be at the Consultants own expense.
- Submit proposed cable and enclosure tag labels to the Contract Administrator and the City of Toronto IT Technical Representative for approval before proceeding with this work.
- Submit red-lined Site Drawings identifying the proposed location of all enclosures including Telecommunication Enclosures, Termination Panels and Work Area Outlets prior to installation and as part of shop drawing submittals.
- Submit site drawings identify the fibre optic backbone cable routes and horizontal cabling routes to be used prior to installation and as part of the shop drawing submittals.
- Prior to x-raying and coring access holes submit red-lined Site Drawings showing the proposed location of the holes.
- Submit red-lined annotated working Drawings to the Contract Administrator, to clearly document the as-built network including details related to: location (closets, work area outlets), cabling (size, length, type, routing), tagging (cable ducting, cabling, closets and work area outlets).
- Submit all submissions in both a hardcopy and electronic native format. Handwritten submissions are not acceptable. Also, submit electronic files in a PDF digital format that is indexed and searchable.
- Submit the following documentation prior to starting the site acceptance test:
 - City of Toronto IT/Network Services — Cable Test Results
 - Operations and Maintenance Manual of any and all electronic equipment to or is installed.
 - Revise and annotate Contract Drawings, to clearly document the as-built network including details related to: location (closets, terminations panels) cabling (size, length,

type, routing), tagging (cable ducting, cabling, closets and termination panels) final as built drawings, cabling schematics, pathways and conduits drawings (containment system), any other documents, reports and drawings needed by the City of Toronto during or after work is completed.

- Consultants shall review and approve all submissions prior to final review by the City.
- Consultant is responsible to submit the final as-built drawings of the project / facility to the City.

END OF SECTION

SECTION -2: PRODUCTS

Products and part numbers often change without notice. The Consultant shall verify all parts specified and used are current and available.

Consultant shall practice the procedure of shop drawings / products approval as stated in this section. Shop drawings shall be submitted by the Contractor to the Consultant. The Consultant / Designer shall review and approve the shop drawings submittal before sending it to the City of Toronto IT for final review. After receiving the submittal from the City IT, the Consultant / Designer shall send the final approval or approval with comments / notes to the Contractor.

APPROVED MANUFACTURERS

- All backbone fibreoptic cables, connectors, patch cords, patch panels, cassettes and adaptors shall be from Belden.
- All CAT6/CAT6A modular jacks, faceplates, U/UTP patch cords and Category 6/6A cables shall be from Belden.
- Where cross connect punch down is required at Entrance Facility for termination of all voice backbone cables, it shall be from Belden.
 - www.belden.com
- All wall mount Telecommunication Enclosures shall be from Hammond Manufacturing.
 - www.hammondmfg.com
- All free standing Paramount Telecommunication Enclosures in the Equipment Room / Telecom Room shall be from Chatsworth Products.
 - www.chatsworth.com
- All fire-stopping EZ-PATH components shall be from Specified Technologies Inc.
 - www.stifirestop.com
- For UPS and Power Distribution Unit, Liebert - Emerson and APC shall be the manufacturers.
 - www.emersonnetworkpower.com ; www.apc.com
- Manufacturer Substitution of any part other than those specified in this standard is strictly prohibited without the written consent of the City of Toronto Information Technology (IT) Network Services Division.

ENTRANCE FACILITY PROTECTION

- Indoor voltage protector to protect entrance terminal to provide voltage and current protection and a disconnect facility at building entry points.
- Integral, 28 AWG (0.32 mm), non-replaceable fuse link wire between the incoming pairs and the protector modules.
- 25-pair connector for single-pair terminations (one pair "IN", one pair "OUT"), compatible with 22 to 26 AWG.
- The protected entrance terminal shall comply with CSA specification C22.2, No. 226-92, "Protectors in Telecommunication Networks," including the high-voltage fault test.
- Protectors to be included with supplied assembly.
- Consultant to use Belden data sheet to specify correct part number for the application.

FIRE RATED BACKBOARD PLYWOOD

- In the Entrance Facility, Equipment Room and Telecom Room Fire Rated plywood shall be provided on the walls or struts such that there is proper cable penetration from behind.
- Plywood shall be void-free and either fire-rated or treated on all sides with at least two coats of fire-retardant light-colored paint.
- Have at least two walls lined with A/C grade or better, 2.4 m (8 ft) high with a minimum thickness of 19 mm (3/4 in). To reduce warping, plywood should be kiln-dried to maximum moisture content of 15 percent. Mount plywood 200 mm (8 in) AFF to avoid damaging the plywood. Have the plywood with the grade A surface exposed. The plywood should be securely fastened to wall-framing members to ensure that it can support attached equipment.
- All joints screw and nail holes are to be caulked and / or covered.
- The plywood is to be provided for cross-connect fields, security panels, power supplies etc. as may be required and is not intended for cabinet installation.

NETWORK CABINETS (CORE AND SERVER CLOSETS)

- 44U Floor Standing Cabinets
 - Cabinets shall be supplied and installed complete with all accessories to provide a complete cabinet as indicated below.

- Cabinets shall be floor mounted, freestanding and have the ability to be ganged together.
- Cabinets shall have a capacity of 44U with mounting holes as per EIA-310-E.
- Each server cabinet shall be black with square hole rails.
- Each network / service provider cabinet shall be black with round hole rails.
- Specified Product:
 - W762mm X D1067mm X H2133mm Cabinet
 - Front Door
 - Rear Split Door
 - Solid Side Panels
 - Rackmount rails (square for server and round for network cabinets)
 - Top Panel
 - 483 mm (19") Mounts with cage nuts
 - 10-32 Cage nuts and screws (square for server and round for network cabinets)
- Electrical
 - Contractor is to provide the electrical distribution for each IT Network and Server cabinet as per the related Electrical Distribution drawings and relevant City standards.
 - Bond each 19" cabinet to ground.
 - Provide each Core and Server cabinet with two (2) 20A, 120 VAC, receptacles for UPS circuits. Terminate each UPS circuit at a 3-wire, duplex receptacle mounted to the rail of the 19" cabinet.
 - The duplex receptacles shall be mounted in such a manner as not to interfere with access to or removal of other equipment within the enclosures.
 - Power distribution within the enclosure shall be via vertically mounted metered power bars.
 - Redundant power supplies, within the same device, shall not be connected to the same UPS circuit.

- Power Distribution Unit (PDU – Power Bar)
 - The Liebert MPH rack PDU shall be managed three-phase power distribution unit that shall be monitoring along with receptacle control.
 - Liebert MPH units shall be available for mounting in either vertical, zero-U configuration and rack-mounting in standard, network enclosures.
 - The output receptacles support equipment requiring connection with NEMA 5-20R and IEC60320-C13 plugs.
 - Remote monitoring shall be enabled by the included communication card, the Liebert RPC™, which permits managing the Liebert MPH over a secure Web page and SNMP-based network management system.
 - The Liebert RPC shall permit interconnecting multiple Liebert MPH and / or Liebert MPX units for monitoring and management.
 - A Liebert MPH shall be monitored locally with an RPC BDM™, an optional display module that connects directly to the communication card. The display module can be handheld, mounted in or on the rack or mounted on a nearby wall.
 - Multiple Liebert MPHs can be centrally managed with Liebert Nform™, which adds group-based receptacle management.

TELECOMMUNICATIONS ENCLOSURE (TE)

- Unless otherwise specified all indoor enclosures containing network components are to be NEMA 12.
- A lockable double hinged door allows front and rear access to rack-mounted components.
- All screws, bolts, fasteners etc. shall be corrosion resistant stainless steel.
- All wall-mounted panels shall be separated from the wall by stainless steel spacers or galvanized steel struts.
- Doors shall have continuous hinges with removable pin and oil resistance cellular neoprene gasket secured by gasket retainers. Front door handles shall be recessed type (freestanding enclosures) or 3-point external latch (wall mount), complete with key locks.
- Provide locking mechanism for rear door. All key locks shall be identically keyed.
- Key number shall be provided.

- Cable bundles shall be neatly laced, run in ducting or approved cable managers and secured to 19" cabinet or mounting back-panel.
- All enclosure doors shall open through 180 degrees without restriction from front and the back.
- Enclosure layout and equipment spacing shall be constructed to allow for device removal, calibration and maintenance without disassembly of adjacent devices.
- All enclosures shall have sufficient structural reinforcements to ensure a limited plane surface vibration and to provide rigidity during shipment, installation and operation without distortion or damage to the enclosure, mounting panel or mounted instruments.
- All enclosure seams shall be continuously welded and ground smooth to be undetectable after painting.
- Devices shall be installed on the enclosure back-panel or 19" cabinet only.
- There shall be no devices installed on the side plates of the enclosure.
- Conduit accessibility shall be per manufacturer's guidelines with conduit egress through the bottom and sides but not the top of the enclosure.
- There are three sizes of TE, 12U, 19U and 26U. All provided by Hammond Manufacturing.
- Minimum items in the TE shall include but are not limited to one fibre termination panel (1U), three 24 port (1U) patch panels (1 x Telephone and 2 x Data), two (2) 24 ports or one (1) 48 ports Cisco switch, two (2) 2U Horizontal Cable Manager, one (1) 1U monitored PDU and other optional equipment as may be requested by CoT-IT such as UPS or other equipment.
- All TEs shall be bonded to the Telecommunications Bonding System as per the standard.
- The bonding cable shall be sized according to distance and terminated at the nearest Telecommunications Grounding Busbar and run within conduit.
- The TE shall be CSA approved and sealed.
- Provide the enclosure electrical distribution as per the Telecommunication Enclosure (Typical) - Electrical Distribution drawing.
 - The Telecommunication Enclosure shall be powered by two separate 15 A, 120 VAC supplies (Utility and Network). The Utility Supply is to power non-critical components (enclosure lighting and power bar). The Network Supply (UPS) is to power the critical network components (Ethernet Switch) and environmental controls (ventilating fans).

Contractor shall provide the Utility Supply from the nearest lighting panel as per the TE Installation drawings. The Network Supply is to be provided by others. Where applicable, the Contractor shall provide a 15A Supplementary DIN rail mounted breaker for termination of the Network Supply. In addition, the Contractor shall provide a knockout for the Network Supply conduit as per the Access Closet Installation drawings. All power distribution installation shall be mounted to the top rear side of the TE.

- Provide 120 VAC, 3-wire, duplex receptacles, circuit breakers, surge suppressor, wire duct and grounding bar per the Telecommunication Enclosure Layout drawing and associated Component Schedule. The Contractor shall provide rigid-steel conduit and wiring to provide the 15 A, 120 VAC Utility Supply as per the Access Closet Installation drawings. The Utility Supply shall be terminated at a 15 A, DIN rail mounted, circuit breaker and surge suppressor. Distribution of the Utility Supply is as documented in the Telecommunications Enclosure – Electrical Distribution drawing.
- All power distribution installation shall be mounted to the top rear side of the TE.
- A rack mount UPS shall be supplied that will power the Telecommunication Enclosure Network Supply. The Contractor shall be responsible for the distribution of the Network Supply within the TE and for providing a 15 A supplemental breaker for termination of the supply by others.
- Power Distribution Unit (PDU - APC)
 - The APC rack mount PDU/transfer switch shall be managed three-phase power distribution unit that monitoring along with receptacle control.
 - The APC units shall be available for rack-mounting in standard, network enclosures.
 - The output receptacles support equipment requiring connections (10) with NEMA 5-15R.
 - Remote monitoring shall be enabled with a secure Web page and SNMP-based network management system.
 - The APC PDU shall permit interconnecting multiple units for monitoring and management.

WORK AREA OUTLETS FOR OFFICE AREA

- All modular jacks, faceplates and furniture inserts shall be Belden and performance rated to Category 6/6A.

- Provide one 4-port, single-gang, work area outlet in each work area for termination of the horizontal CAT6/6A cables with faceplates or decora module frames.
- For new construction, it is recommended that the outlet boxes be 100mm X 100mm X 54mm deep, complete with a mud ring cover specifically designed for single gang faceplates intended for flush mounting to the wall. This single gang outlet box aids in the maintaining of Category 6/6A and higher bend radius requirements.
- Where walls are not suitable or have insufficient depth, standard electrical size outlet boxes shall be used.
- Each manager's office shall have two (2) work area outlets on separate walls.
- One (1) 4-port, work-area outlet shall be associated with as many ports necessary (in groups of 4 or 2) on the snap-in faceplate installed in the patch panel of the TE or TR as is provided.
- Within each office outlet, only two of the ports shall be terminated at the work area faceplate and patch panel unless otherwise specified.
- Space shall be left in each conduit and faceplate for a third and fourth cable to be added at a later time.
- In the majority of cases one (1) 4-port, work-area outlet shall be installed within each systems furniture cubical work area partition.
- In some special situations where the systems furniture is configured fully the work-area outlet shall be installed directly on the wall in the office areas.
- Within systems furniture, only two of the four positions shall be terminated with work area jacks and on the patch panels unless otherwise specified.
- Space shall be left in conduits and faceplates for the inclusion of a third and fourth cable at a later time.
- In boardrooms and large general office areas, one single gang work area outlet shall be provided every 3.0 metres and within 1.0 metres of an electrical outlet if provided.
- Only two of the four positions shall be terminated with work area jacks and on the patch panels unless otherwise specified.

FACEPLATES

- Faceplates shall be modular Belden white format opening to allow the possibility of changing connector types in the future without replacing the entire unit.
- Faceplates shall be equipped with small form factor terminating connectors to fit the individual outlet's requirements
- Faceplates shall be equipped with a minimum of four (4) openings for modules. Contractors are to equip the faceplate with the required number of blank inserts as required.

WORKSTATION FACEPLATES AND ADAPTERS - CUBICLES

- Workstation outlets shall be supplied and installed for all terminations at the workstation end and as further specified below to suit the application.
- Each workstation shall be equipped with minimum two (2) RJ45 Cat6/6A green color jacks.
- The Communications Consultant shall confirm the color of outlets prior to placing order.
- Modular Furniture Faceplates
 - Modular furniture faceplates shall be installed in all furniture outlets that have a modular furniture knockout shall consist of 4 ports.
 - Each outlet shall be installed with the specified termination modules or a blank insert. No openings shall remain exposed.
 - Communications Consultant shall verify furniture modular faceplate requirement.
 - Belden MDVO modular furniture adapter, 4 port, white
 - Belden MDVO modular furniture adapter, 4 port, black
- Surface Mount Boxes
 - Surface mount boxes shall be installed for all furniture outlets that do not have a modular furniture knockout, exposed ceiling outlets or any location not provided with an electrical back box.
 - The surface mounted box shall consist of a minimum of two (2) ports.
 - Each outlet shall be installed with the specified termination modules or a blank insert. No openings are to remain exposed.

- Belden MDVO side entry box, white
- Belden MDVO side entry box, black

RJ45 CAT6/6A JACKS

- Belden Eight-position modular jack (RJ45), type Category 6/6A to TIA-568 shall be green color and shall have the following minimum performance characteristics:
 - Modular jack current rating: 1.5 Amperes maximum
 - Modular jack durability 1,000 mating cycles
 - Modular jack contact Pressure: 100 grams minimum per contact
 - Dielectric voltage strength: 1,000 V RMS at 60Hz for 1 minute
 - Insulation resistance: 200 milli-ohms minimum
 - Contact resistance 1 milli-ohms per contact
- The contact material of the jack in a modular jack connector shall be phosphor bronze with 50 micro-inches of gold over nickel.
- UTP termination modules shall be of the same category as the UTP cabling to ensure that manufacturer end to end warranties can be attained.
- UTP cables used for IP voice shall be terminated with the same specified jacks.
- All UTP termination modules shall be Belden MDVO type.
- Belden CAT6/6A modular jack, MDVO style, green color.
- Belden ID data tab, MDVO style, green color.

COPPER PATCH PANEL (CPP)

- All horizontal CAT6/6A U/UTP cabling shall be terminated on 1U, 24 ports, Belden CAT6/6A modular patch panel.
- All copper patch panels shall be black.
- All modular patch panels shall be populated with CAT6/6A UTP modules/jacks as required.
- The modular copper patch panel shall mount to standard TIA 482.6 mm (19") rack.

- Contractor to refer to installation instructions provided with the patch panel for proper installation.

COPPER CAT6/6A HORIZONTAL CABLE (U/UTP)

- Belden, four-pair, 100 ohm balanced unshielded-twisted-pair (U/UTP) cable, appropriate flame test classification, Category 6/6A (CAT 6/6A) shall be in compliance to TIA-568 standard.
- All cables fully contained within conduit or areas that are not plenum rated shall use CMR/FT4 rated cable.
- Any cable, regardless of length passing through a return air plenum ceiling and not in conduit shall be rated CMP/FT6.
- All UTP cables shall meet requirements identified below:
 - Color: Blue
 - Rating: CMR/FT4 (riser rated or in conduit) or CMP/FT6 (plenum areas or in J-hooks)
 - Category: 6/6A
 - 23 AWG, spool-in-a-box
- All CAT6/6A horizontal cables shall be eligible for the Belden 25 years Certification Warranty.
- Cabling shall be installed and terminated as per the BICSI Installation Methods Manual, Belden Certification training and the manufacturers' installation instructions.

COPPER CAT6/6A PATCH CORD (U/UTP)

- Patch cord shall be manufactured of stranded conductor cable with 8-position, 4-pair terminations at both ends.
- All patch cords shall be manufactured by Belden and performance rated to CAT 6/6A.
- All patch cords shall be of the same or higher performance category and manufacturer of the U/UTP horizontal cabling system that shall be warranted as part of the end-to-end solution.
- All patch cords shall be standard compliant and minimum of FT4 or LSZH rated.
- All patch cords shall be manufactured and certified, 4-pair stranded conductors copper cables, field assembled patch cords are not allowed.

- All patch cords shall be gray in color.
- The Contractor shall supply patch cords in the following length:
 - At patch panel location, provide 0.5 metres long patch cords for all terminated horizontal cables unless otherwise advised by Consultant or CoT-IT.
 - At workstation or work area outlet location, provide patch cords of suitable length and not longer than 5 metres (typically 2.1 metres but Project Consultant to finalize) for every terminated horizontal cable unless otherwise advised by Consultant or CoT-IT.
- Patch cords shall be installed and terminated into the final device by the Contractor as per the BICSI Installation Methods Manual, Belden Certification training and the manufacturer's installation instructions.

BACKBONE CABLE FOR VOICE CENTREX ONLY - ISP (CAT3/5E)

- Category 3/5e rated wire and cable placed in the inside environment shall be solid, 24 AWG, twisted pair and multi-conductor.
- All cables fully contained within conduit or areas that are not plenum rated shall use CMR rated cable.
- Any cable, regardless of length passing through a return air plenum ceiling and not in conduit shall be rated CMP.
 - Belden: CMR: min 25 pairs | CMP: min 25 pairs

TELEPHONE PATCH PANEL FOR VOICE (TPP)

- Minimum 1U 24 RJ45 UTP ports.
- Accommodates 180, 110, or 90 degree patch cord connectors on back of patch panel.
- Does or doesn't require the use of a punch-down tool and mounts to standard EIA 19" rack.
- Belden for voice unloaded patch panel - black
- Belden jacks for voice unloaded patch panel, white – CAT3/5e
- Belden ID voice tab for unloaded patch panel, white

VOICE CROSS CONNECT AT ENTRANCE FACILITY (EF)

- Voice cross-connect is a system that consists of various sizes of BIX blocks, cable distribution accessories (such as moulded rings and strips) and a BIX tool to terminate wires at the BIX block. The voice cross-connect system is primarily composed of two parts: the mount and the connectors.
- Cross-connect mount is a wall-mounted frame, generally built from 16-gauge steel. The frame features a rectangular plastic backplate and two plastic brackets that extend from either side of the backplate to fit between two and ten connectors. The connectors shall be oriented horizontally on the mount.
- The connectors are rectangular punch-down blocks used to terminate up to 25 pairs. The connectors shall have a slip-in fitting which automatically strips the wire as it is punched down, eliminating the need for pre-stripping. The connectors shall also have a pair-splitter to facilitate fast arranging of wires on the punch-down block.
- Backbone cables shall be terminated on the backboard (as shown on drawings) unless otherwise specified in this document.
- All cables shall be terminated on IDC connectors complete with associated hardware such as mounts, cable / cross-connect wire managers, etc.
- The IDC connectors shall accept 24 to 26 AWG solid copper conductors.
- The IDC mounts shall accept cables from behind the connector.
- Cross-connect shall be a 5-pair block and include appropriate mounting and number of designation strips and labels.
- Cable management in the form of distribution rings or approved similar shall be provided between columns and rows of IDC mounts to support cross connect management in a manner recommended by the manufacturer.
- Instruction sheets for products are available from Belden.
- Belden 50 pair BIX mount
- Belden BIX distribution connector – 5 pair marking
- Belden accessories such as jumper wires, labels etc. to complete the system.

FIBROPTIC CABLES

INDOOR BACKBONE MULTIMODE OM4 FIBROPTIC CABLE

- The cable is performance rated to OM4 and shall be used only if the backbone link length is less than or equal to 150 meters.
- Primary and redundant, 12 strands in each cable shall run between the equipment room and the telecom room. Total of 2 x 12 strands shall run with diverse pathways between the equipment and telecom rooms.
- All cables shall be fully contained within conduit or areas that are not plenum rated shall use OFNR/FT4 rated cable.
- Any cable, regardless of length passing through a return air plenum ceiling and not in conduit or using cable tray / J-hook shall be rated OFNP/FT6.
- Fiber cables shall be protected when entering the patch panel with a black color flexible conduit.
- Core-locked, tight-buffered, black, indoor/outdoor fiber-express distribution cables.
- 50/125-micron core/cladding, laser optimized.
- 4700 MHz-km bandwidth at 850nm wavelength (EMB).
- 3500 MHz-km bandwidth at 1300nm wavelength.
- Only cables from Belden shall be accepted.
- All fibreoptics cables shall be installed and terminated into fibre optic adapters contained in fibre optic patch panels by the Contractor as per the BICSI Installation Methods Manual, Belden certification training and installation instructions.
- Belden:
 - OFNR/FT4
 - OFNP/FT6

FIBROPTICS PATCH PANEL (FPP)

- Fibreoptics cabling shall be terminated in patch panels intended for fibre optic cable management.

- Belden Fiberoptics Rack Mount Enclosure for Telecommunication Enclosures shall be:
 - 3U - 19" Rack Mount Enclosure
 - Durable black powder coat finish
 - Be equipped with cable strain relief and slack storage
- Belden Blank Fibre Adapter Panel shall be:
 - Blank Fibre Adapter Panel to fit Fibre Adapter Patch Panel
 - Durable black powder coat finish
- Belden Fiberoptics LC Fibre Adapter Strip shall be:
 - Loaded with TIA-604 FOCIS-10 compatible adapters, TIA-568.3 standard compliant
 - Split sleeve: Zirconia Ceramic
 - Adapter housing colors follow TIA-568.3 suggested color identification scheme.
 - Belden part number for 6 LC duplex adapter strip
- Belden 1U fibre cover, smoked plexiglas
- Belden Splice Case / Modules / Trays for OM4 Cable Terminations shall be:
 - Belden splice tray for 3U rack mount fibre enclosure

FIBEROPTICS LC CONNECTOR FOR FIELD TERMINATION OF OM4 CABLE

- Optical fibre terminations for OM4 cable shall be made for field termination with a pre-polished connector and shall be of the same manufacturer and LC style to suit the cabling installed.
- Fibre connectors shall match the performance of the fiberoptics cable (OM4).
- Fibre terminations shall be made with a ceramic ferrule and cable boot.
- Optical fibre cables shall be terminated with pre-polished connectors having the characteristics as below:
 - Return loss: >20dB (multimode)
 - Termination Style: Pre-Polished

- Connector Type: LC
- Ferrule Type Zirconia Ceramic
- The connector shall include connector body / ferrule assemblies, crimp sleeves, dust caps, clip, and appropriate boot.
- All Fiberoptics connector terminations and adapters shall be contained in fibre optic patch panels from Belden by the Contractor as per the BICSI Installation Methods Manual, Belden certification training and installation instructions

FIBEROPTICS LC PIGTAIL FOR FIELD TERMINATION OF OM4 CABLE

- Optical fibre OM4 cable shall be fusion spliced to pig-tails for field termination and shall be of the same manufacturer and LC style to suit the cabling installed.
- Pigtail shall be OFNR (FT4) or LSZH rated and stamped/printed accordingly.
- The pigtail shall be 100% factory terminated and inspected end face geometry in compliance with Telcordia GR-326-CORE, issue 3.
- Typical insertion loss per pigtail connection: 0.25dB.
- Field assembled pigtails are not allowed.
- The Contractor shall supply and fusion splice every strand of the fibre backbone cable with a pigtail. The pigtail length shall be 1m.
- Belden OM4 pigtail
- Belden fusion splice heat shrink protector sleeves

FIBEROPTICS MULTIMODE LC-LC DUPLEX PATCH CORDS – OM4

- All patch cords shall be CSA/TIA/UL approved, CMR (FT4) or LSZH rated and printed accordingly.
- All optical fibre patch cords shall be OM4.
- All optical fibre patch cords shall be manufactured and certified, 1-pair (duplex, 2 strands). Field assembled patch cord is not allowed.
- The Contractor shall supply a minimum two (2) patch cords for every OM4 backbone cable:

- At patch panel in the telecom room (TE), provide one (1) 2-meter-long patch cord unless otherwise specified by CoT IT.
- At patch panel location in the equipment room (ER), entrance facility (EF), or any other space provide one (1) 2-meter-long patch cord unless otherwise specified by CoT IT.
- All optical fibre patch cords shall be LC to LC duplex.

PATHWAY SYSTEM – CONDUIT AND CABLE TRAY

- Cable tray shall be used above ceilings in commercial facilities and below raised floor systems as may be found in equipment rooms or data centers.
- All pathway (conduit and cable tray) systems shall be designed in accordance with the latest version of the ANSI/TIA-569-E Standard which exceeds the minimum requirements of Canadian Electrical Code. Pathway systems that are designed only to the Canadian Electrical Code and do not include all requirements of the ANSI/TIA-569-E standard will be considered substandard and removed until such time as they are in compliance.
- Consultant to confirm with both the facility and CoT-IT regarding the areas that are suitable for Electrical Metallic Tubing (EMT).

ELECTRICAL METALLIC TUBING CONDUIT - EMT

- To be used within the office areas only (if applicable).
- Electrical Metallic Tubing shall be electro-galvanized steel.

FITTINGS

- Fittings for electrical metallic tubing shall be single screw indenter fittings for conduits up to 2" and double screw indenter fittings for conduits 2" and larger.
- Die-cast or pressure cast fittings are not permitted.
- Connectors shall have insulated throat up to and including 1" size. For sizes 1-1/4" and larger, provide plastic insulating bushing.
- Provide conduit body types, shapes and sizes as required to suit application and NEC requirements. Provide matching gasket covers secured with corrosion-resistant screws.

EXPANSION FITTINGS

- Provide expansion fittings with external grounding straps at building expansion joints.
- Minimum 4" movement in either direction.
- At expansion joints in concrete pours, provide deflection/expansion fittings capable of movement of $\frac{3}{4}$ " in all directions from the normal.

WATER PROOFING SEALS

- Provide watertight expanding link-type seals for installation between the conduit and the sleeve or core drilled hole.

WIRE BASKET TRAY

- The wire basket tray shall be 12 – 13 gauge, straight sections shall be powder coated black with an average paint thickness of 1.2 mils (30 microns) to 3.0 mils (75 microns).
- Tray shall be designed in such a way as to be secured to the following, but not limited to: wall, ceiling every 1.2 metres.
- Splicing trays shall be accomplished by using a single manufacturer supplied UL classified connector bolt or splice plate.
- Depth: Tray depth shall be (unless otherwise shown on the drawings) 100mm (4 inches).
- Width: Tray width shall be (unless otherwise shown on the drawings) 300mm (12 inches).
- Turning Fences shall maintain approved bend radius and be constructed from sheet steel and plated in accordance with applicable standards.
- Intersections shall be made from high strength steel, welded and plated in accordance with applicable standards.
- Proper manufactured accessories and fittings such as elbows, reduces, crossovers, tees and riser shall be used for any change in direction, height or size of the cable basket tray.
- Support cable tray to suit loading and recommended support requirements in the Canadian Electrical Code Part II.
- Materials bolted or riveted to the cable tray shall be free of burrs and or sharp edges.

VENTILATED CABLE TRAYS

- All cable tray systems shall be designed in accordance with the latest version of the ANSI/TIA-569-E Standard and BICSI TDMM which exceed the minimum requirements of Canadian Electrical Code. Cable tray systems that are designed only to the Canadian Electrical Code and do not include all requirements of the ANSI/TIA-569-E Standard and BICSI TDMM shall be considered substandard and removed until such time as they are in compliance.
- Consultant to confirm with both the facility and CoT-IT regarding the areas that are suitable for cable tray, if suitable, what material type given the impact of certain airborne chemicals (aka Chlorine) that corrode metals.
- The ventilated cable tray is preferred to be used for horizontal cable distribution.
- The ventilated cable tray shall include but not be limited to the following characteristics:
 - A prefabricated structure consisting of a ventilated bottom with integral longitudinal side rails with no openings exceeding 50mm or 2" in a longitudinal direction.
 - Shall be prefabricated from a pre-punched sheet to produce a one-piece ventilated tray.
 - Shall be available in Aluminum, pre-galvanized Steel, hot dip Galvanized Steel and Stainless Steel 316.
 - Shall be a minimum of 103mm or 4" in depth or as appropriately designed and approved by Project Consultant and CoT-IT.
 - Proper manufactured accessories and fittings such as elbows, reduces, crossovers, tees and riser shall be used for any change in direction, height or size of the cable tray.
 - Spine type cable tray is not acceptable.
 - Support cable tray to suit loading and recommended support requirements in the Canadian Electrical Code Part II.
 - The support shall be placed within a maximum of 610mm on either side of any connection to a fitting.
 - Materials bolted or riveted to the cable tray shall be free of burrs and or sharp edges.

JUNCTION BOX

- All junction box applications shall be designed in accordance with the latest version of the ANSI/TIA-569-E Standard and BICSI TDMM which exceed the minimum requirements of Canadian Electrical Code. Application of junction boxes that are only designed to the Canadian Electrical Code and do not include all requirements of the ANSI/TIA-569-E Standard and BICSI TDMM shall be considered substandard and removed until such time as they are in compliance.
- Consultant to confirm with both the facility and CoT-IT regarding the areas that are suitable for junction box construction type given the impact of certain airborne chemicals (aka Chlorine) that corrode metals.
- For standard non chemically hazardous environments junction boxes shall be constructed of not less than 14-gauge galvanized steel with trim for flush or surface mounting in accordance with the location to be installed.
- Provide screw-on type cover boxes installed in damp or wet locations shall be of rain-tight construction with gasketed cover and threaded conduit hubs.
- Boxes shall be NEMA approved for the environmental condition of the location where they will be installed.

POKE THROUGH FLOOR BOX

- Where office facilities exist but access for cable distribution from above is not possible it may be practical to serve the floor from the ceiling space below with a Poke Through.
- Aluminum modular fire rated poke-through floor boxes coverings.
- Installs in 4" (101.6mm) diameter core drilled hole through concrete.
- UL listed for use in 1-4 hour rated floors.
- Poke-through fitting and universal cover combination exceed UL514A scrub water exclusion requirements.
- Stationary fire barrier expands during fire conditions to provide upper fire seal with adjustable fire barrier that would accommodate concrete floor thickness from 2-1/4" to 7".
- Dual 1" E.M.T. conduit tubes feed from communications feed and one for the electrical (when needed).
- Furniture feed for both power and communication services to modular furniture systems.

- Poke-through to have dual panels, one to hold four (4) RJ45 CAT6/6A Data/Voice ports. The other panel will have a blank plate.
- One-piece dual style line Poke-Through aluminum finish.
- Aluminum modular fire rated poke-through floor boxes coverings.
- Installs in 4" (101.6mm) diameter core drilled hole through concrete.
- UL listed for use in 1-4 hour rated floors.
- Poke-through fitting and universal cover combination exceed UL514A scrub water exclusion requirements.
- Stationary fire barrier expands during fire conditions to provide upper fire seal with adjustable fire barrier that would accommodate concrete floor thickness from 2-1/4" to 7".

GROUNDING AND BONDING

- All bonding to ground systems shall be designed and installed in accordance with the latest version of the ANSI/TIA-607-D Standard and BICSI TDMM which exceed the minimum requirements of the Canadian Electrical Code. Grounding and Bonding for Communications that are designed only to the Canadian Electrical Code and do not include all requirements of the ANSI/TIA-607-D Standard and BICSI TDMM shall be considered substandard and removed until such time as they are in compliance.
- Consultant to confirm with both the facility and CoT-IT regarding the areas that are suitable bonding and grounding points given the impact of certain airborne chemicals (aka Chlorine) that corrode metals.

PRIMARY BONDING BUSBAR (PBB) / TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

- An insulated predrilled copper busbar listed by NRTL, electro-tin plated with holes 8mm diameter for use with standard-sized lugs.
- Dimensions 6mm thick, 100mm wide, variable length as applicable.
- Shall be insulated from its support by a minimum of 50mm.

SECONDARY BONDING BUSBAR (SBB) / TELECOMMUNICATIONS GROUNDING BUSBAR (TGB)

- Predrilled copper busbar listed by NRTL, electro tin plated with holes 8mm diameter for use with standard-sized lugs.
- Dimensions 6mm thick, 50mm wide, variable length as applicable.
- Shall be insulated from its support by a minimum of 50mm.

TELECOMMUNICATIONS BONDING BACKBONE (TBB)

- Cable assemblies shall be UL Listed and CSA Certified and be a minimum of 6 AWG copper conductor, green insulated.
- Telecommunications Grounding and Bonding Conductor Label Kits shall be supplied and installed by the Electrical Contractor at every rack and cabinet as well as one for every Telecommunications Grounding Busbar.
- The bonding conductor size shall be as follows:

TBB Length in Linear metres Metres (feet)	TBB Size (AWG)
Less than 4 (13)	6
4-6 (14 – 20)	4
6-8 (21 – 26)	3
8 – 10 (34 – 41)	2
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
Greater than 20 (66)	3/0

TELECOMMUNICATIONS BONDING CONDUCTOR (TBC)

- Cable assemblies shall be UL Listed and CSA Certified and be a minimum, the same size as the largest TBB copper conductor.
- Shall be green insulated and marked in accordance with ANSI/TIA-607-D.

WARNING LABELS

- Non-metallic warning labels in English: TIA-607-D.
- Identify labels with wording "If this connector is loose, please call the building telecommunications manager or site / area supervisor".

FIRE-STOPPING

- A fire-stop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Firestop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.
- All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate fire-stop system (EZ-PATH). This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly fire-stopped with EZ-PATH.
- Firestop systems shall be UL Classified to ASTM E814 (UL 1479) and shall be approved by a qualified Professional Engineer (PE), licensed (actual or reciprocal) in the state where the work is to be performed. A drawing showing the proposed fire-stop system, stamped/embossed by the Professional Engineer of Ontario (P.Eng.), shall be provided to the Owner's Technical Representative prior to installing the fire-stop system(s).
- EZ-PATH Part Numbers:
 - EZ-PATH Series 22, 33 and 44 (size based on cable quantities).

END OF SECTION

SECTION – 3: EXECUTION

It is Consultant / Designer responsibility to check the latest version of this document from CoT-IT.

GENERAL

- RCDD certified engineer shall perform the design and consulting work.
- Contractors / Technicians shall be certified with Belden and Fluke Networks to perform installations and testing / commissioning.
- Contractors must have an RCDD installation Team Lead / Project Manager.
- Technicians who have not completed the appropriate certification or training shall not pull, terminate or otherwise be involved in the installation of the telecommunications physical infrastructure with the exception of bonding to ground.
- Installers performing the testing (SAT, Acceptance, Commissioning, etc.) shall be Certified Cabling Test Technician on Fluke DSX / Versiv and Optifibre OTDR equipment.
- Following are the procedures to follow for successful project handing over:
 - Cable Acceptance Testing (CAT) – See Appendix for correct Sample Test Results and Compliance Sheet
 - Site Acceptance Testing (SAT) - See Appendix for Sample SAT Documents
 - As-built Drawings and Documents (ADD)
 - Consultant Review and Comments (CRC)
 - CoT-IT Approval of Satisfaction (AoS) – Signing off

HORIZONTAL CABLE INSTALLATION

- All cables and components shall be installed as per the Belden's instruction sheets, ANSI/TIA standards and the BICSI Installation Methods Manual to complete the project.
- All testing of the Category 6/6A cabling system shall be with Fluke DSX-5000 / 8000 Versiv Cable Analyzers.

FIBREOPTIC CABLE INSTALLATION

- All cables and components shall be installed as per Belden's instruction sheets, ANSI/TIA standards and the BICSI Installation Methods Manual to complete the project.
- All testing of the fibre optic installation shall be with test equipment from Fluke DSX-5000 / 8000 Versiv and if required (upon CoT-IT request) Optifibre OTDR.

CABLE ACCEPTANCE TESTING

- This section specifies the acceptance testing requirements for backbone fibre optic as well as horizontal UTP cabling.
- Supply all of the test equipment required to conduct acceptance tests.
- Submit acceptance documentation as defined in this section.
- All of the installed cabling must be tested and successfully pass all test criteria.
- Standards referenced in this section include:
 - ANSI/TIA-568: Telecommunications Cabling Standard. All standards referenced within the TIA-568, where applicable, constitute standard provisions of this specification.
 - ANSI/TIA-526-14: Optical Power Loss Measurement, Multimode
 - ANSI/TIA-526-7: Optical Power Loss Measurement, Single-mode
 - ANSI/TIA-1152: Requirements for field test instruments and measurements for balanced twisted-pair cabling
- Visually inspect all cables, cable reels and shipping cartons to detect possible cable damage incurred during shipping and transport. Visibly damaged goods shall be returned to the supplier and replaced at no additional cost to the City.
- All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA-568 standard. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed without cost to the City.

COPPER PERMANENT LINK TESTING – HORIZONTAL CABLING

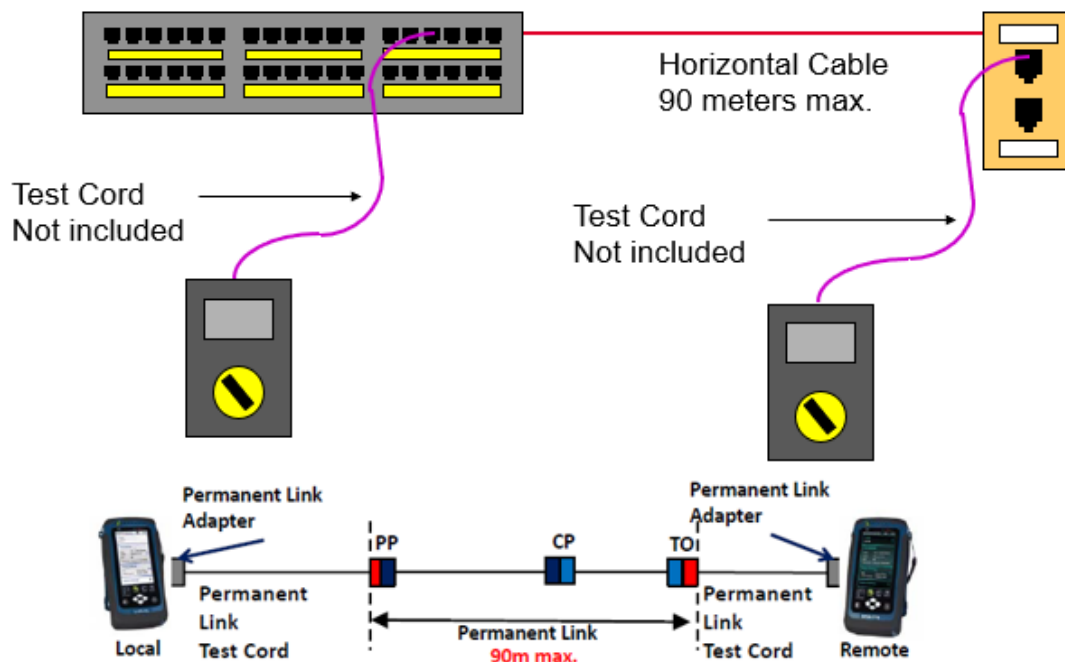
- All unshielded twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance to Category 6/6A. Horizontal cabling shall be tested using a minimum level IIIe test unit for Category 6/6A performance compliance.
- Continuity - Each pair of installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by the test unit and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
- Length - Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA-568.2 standard. Cable length shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cable, the shortest pair length shall be recorded as the length for the cable.
- Horizontal twisted pair cable shall meet or exceed the permanent link, performance requirements specified in ANSI/TIA-568.2 for Category 6/6A, Unshielded Twisted Pair (U/UTP).
- All tests shall be conducted using permanent link configuration on the testing equipment.

COPPER TEST EQUIPMENT

- Category 6/6A Test Equipment - Category 6/6A test equipment shall meet the following minimum criteria:
 - All test equipment of a given type shall be from the same manufacturer and have compatible electronic results output. Acceptable test equipment manufacturer is Fluke Networks. Unless the manufacturer specifies a more frequent calibration cycle, calibration date shall be not more than a year from cable test date. Recommended test equipment is a Fluke Networks DSX 5000 / 8000 Versiv Cable Analyzer.
 - Test adapters must be approved by the manufacturer of the test equipment. Adapters from other sources are not acceptable. For horizontal cabling, permanent link adapters shall be used.
 - Baseline accuracy of the test equipment must meet or exceed TIA Level IIIe, as indicated by independent laboratory testing.

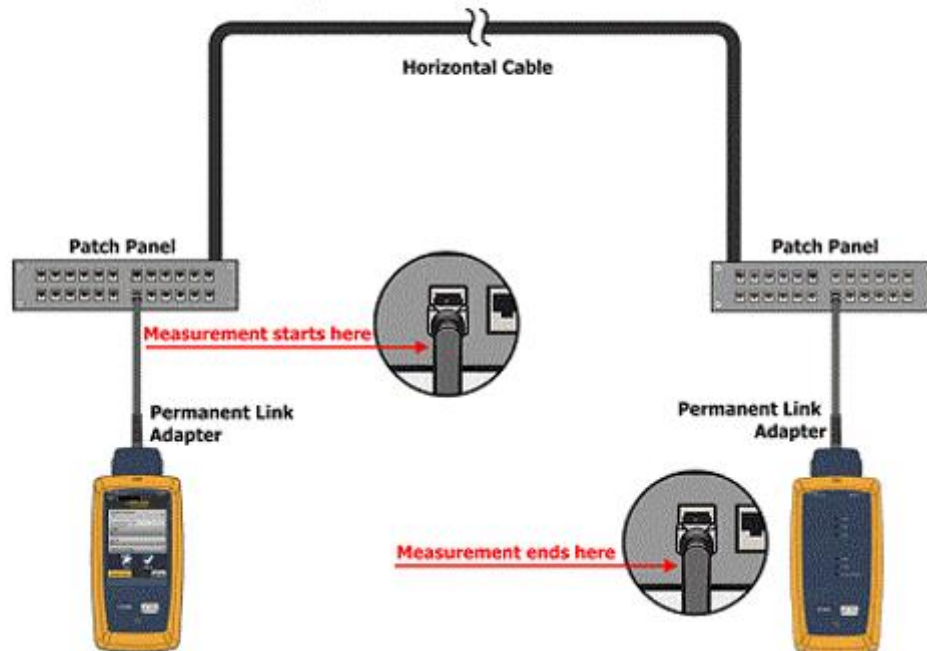
- Test equipment must be capable of certifying Category 6/6A to TIA-568.2 standard.
- Test equipment must have a dynamic range of at least 100 dB to minimize measurement uncertainty.
- Test equipment must be capable of storing full frequency sweep data for all tests.
- Test equipment must include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.
- Test equipment must be capable of running individual NEXT, return loss, etc., measurements in addition to auto tests. Individual tests increase productivity when diagnosing faults.
- Test equipment must make swept frequency measurements in compliance with ANSI/TIA-568.2 standard.
- The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.
- The calibration of equipment shall be valid within one (1) year of the test date.

■ Permanent Link in LAN



■ Permanent Link Test in DC

Data center two connector permanent link definition:



HORIZONTAL CABLE TESTING DOCUMENTATION - COPPER

- Category 6/6A (UTP) Documentation - As a minimum, test reports shall include the following information for each U/UTP CAT6/6A cabling element tested:
 - Wiremap results that indicate the cabling has no shorts, opens, split, reversed, or crossed pairs and end-to-end connectivity is achieved.
 - Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT and PSELFEXT data that indicate the worst-case result, the frequency at which it occurs, the limit at that point and the margin. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combinations and in both directions when required by the appropriate standards.
 - Length (in meters), propagation delay and delay skew relative to the limit.
 - Any individual test that fails the relevant performance specification shall be marked as a FAIL.

- Cable manufacturer, cable model number/type and NVP.
- Tester, manufacturer, model, serial number, hardware version and software version.
- Circuit ID number (Cable Tag Id) and Facility name.
- Test criteria used.
- Overall pass/fail indication.
- Date and time of test.

BACKBONE FIBREOPTIC TESTING

- Backbone fibre optic cable shall meet or exceed the permanent link, performance requirements specified in ANSI/TIA-568.3 for multimode and singlemode fibre.
- Test link attenuation with an OLTS:
 - For multimode fibre, make reference measurements in accordance with TIA-526-14, Annex A – One cord reference method. Measure optical loss on each fibre at 850nm and 1300nm. It is required to measure loss on each fibre from each direction (bi-directional).
 - For singlemode fibre, make reference measurements in accordance with TIA-526-7, one cord reference method. Measure optical loss on each fibre at 1310nm and 1550nm. It is required to measure loss on each fibre from each direction (bi-directional).
- Measure link length optically or calculate using cable sheath length markings.
- Multimode backbone fibre optic cabling shall meet the following loss and length criteria:
 - Attenuation @ 850nm shall be less than or equal to: fibre length (km) x 3.0 dB/km + number connector pairs x 0.5 dB + number of splices x 0.3 dB.
 - Attenuation @ 1300nm shall be less than or equal to: fibre length (km) x 1.5 dB/km + number connector pairs x 0.5 dB + number of splices x 0.3 dB.
 - Length shall be less than or equal to 150 meters.
- VCSEL driver is preferred to be used for testing as the SFP active modules on the switch runs with VCSEL drivers up to 10Gbps.
- Singlemode backbone fibre optic cabling shall meet the following loss and length criteria:

- Attenuation @ 1310nm shall be less than or equal to: fibre length (km) x 0.4 dB/km + number connector pairs x 0.75 dB + number of splices x 0.3 dB.
- Attenuation @ 1550nm shall be less than or equal to: fibre length (km) x 0.4 dB/km + number connector pairs x 0.75 dB + number of splices x 0.3 dB.
- Length more than 150 metres and shall be less than or equal to 10000 meters.

BACKBONE FIBREOPTICS TESTING DOCUMENTATION

- Fibreoptics Documentation: As a minimum, test reports shall include the following information for each fibreoptics cabling element (fibre) tested:
 - Actual measured attenuation, maximum allowable attenuation (loss) and the attenuation margin at the specified wavelengths. An individual test that fails the link criteria shall be marked as FAIL.
 - Reference method.
 - Number of mated connectors.
 - Actual length and maximum allowable length. Any individual test that fails the link length criteria shall be marked as FAIL.
 - Group refractive index (GRI) for the type of fibre tested, if length was optically measured.
 - Tester manufacturer, model, serial number and software version.
 - Circuit ID number (Cable Tag ID) and facility name.
 - Link criteria used.
 - Overall pass/fail indication.
 - Date and time of test.

FIBREOPTIC TEST EQUIPMENT

- All test equipment of a given type shall be from the same manufacturer and have compatible electronic results output. Acceptable test equipment manufacturer is Fluke Networks. Unless the manufacturer specifies a more frequent calibration cycle, calibration date shall not be more than a year from cable test date. Recommended test equipment is a Fluke Networks DSX-5000 /

8000 Versiv Cable Analyzers using VCSEL fibre modules (preferred) for multimode testing and/or OptiFiber OTDR (if advised by CoT-IT).

- The calibration of equipment shall be valid within one (1) year of the test date.
- Fiberoptics test equipment shall meet the following minimum criteria:
 - Test equipment shall be capable of measuring relative or absolute optical power in accordance with TIA-526-14, "Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant."
 - Test equipment shall be capable of measuring relative or absolute optical power in accordance with TIA-526-7, "Optical Power Loss Measurement of Installed Single-mode Fibre Cable Plant."
 - Test equipment shall not include the loss or length of the test jumpers in the cable plant measurements.
 - Multimode test equipment shall incorporate both 850nm and 1300nm VCSEL/LED sources.
 - Single-mode test equipment shall incorporate both 1310nm and 1550nm laser sources.
 - Sources and meters shall automatically synchronize wavelengths to prevent calibration-related errors.
 - Test equipment shall employ a communications port to facilitate uploading of saved information from tester to PC.
 - Test equipment capable of measuring a Tx/Rx fibre pair simultaneously is recommended to enhance productivity. It is recommended that test equipment utilizing dual function main and remote units be used for bi-directional testing, eliminating the need to swap optical source and power meter.

CABLE TEST RESULTS MANUAL

- Consulting Engineer shall first review and comment on the test report. CoT-IT shall only receive the report after the review and approved comments of the Consulting Engineer. CoT-IT will finally provide their final review comment.
- Submit test reports in both a hardcopy and electronic format (native file). Hand-written test reports are not acceptable. If test results cannot be converted to a PDF format then provide any necessary proprietary/native software to view the results at no cost to the City.

- Fibre optic backbone cable test results shall be incorporated in the City of Toronto, Network - Cable Test Results manual. Submit two (2) copies of the Cable Test Results manual for each facility. The manual consists of hardcopy test result reports placed into lockable 'D' ring binders with a cover and spine that clearly indicates the title of the manual. Put a CD with the electronic copies of test reports in a pocket in the Cable Test Results manual.
- The Contractor (RCDD) PM must sign hardcopy reports before submitting it to the Consultant.

TEST COMPLIANCE SHEET

- A compliance sheet shall be prepared for every project of City of Toronto - IT. The criteria is summarized as below:

1	Test equipment with latest software version	8	Test results limits - TIA
2	Test equipment with latest test limit version	9	Test results based on VCSEL/LED Encircled Flux for OM4
3	Calibration of test equipment	10	Test results based on Laser for OS2
4	Test results submitted in native format and PDF format	11	MM testing at 850nm and 1300nm wavelength
5	Test result cable ID in compliance	12	SM testing at 1310nm and 1550nm wavelength
6	Permanent Link testing performed on copper (CAT6/6A)	13	Bi-directional testing
7	Test result cable type (copper and fibre) in compliance	14	Accurate quantity of adapters and splices

SITE ACCEPTANCE TEST (SAT)

- A Site Acceptance Test (SAT) will NOT test functionality of the system or its components. Site Acceptance Tests will evaluate the workmanship and verify installation against the *Installation* and *Layout* drawings.
- The SAT plan shall be submitted to CoT-IT, two (2) weeks in advance of commencement.

- The SAT plan shall have a checklist and identify tests with a schedule for CoT-IT to review and coordinate staff. Submit to the Contract Administrator/Project Manager and Consultant, three weeks prior to the commencement of the test, for review. The Contractor shall conduct the test when directed by the Contract Administrator. As a minimum, the Contract Administrator/Project Manager, Consultant and CoT-IT shall witness the test.
- The plan shall be sealed by the Installation Project Manager RCDD, followed by the RCDD Consultant.
- Prior to SAT, the Consultant shall review and approve all copper and fibre cabling testing, bonding and grounding inspections and any other criteria as may be described in the project tender.
- The SAT shall evaluate workmanship and verify construction and components against the Layout Drawings and associated Component Schedules submitted to and reviewed by the Consultant.
- The SAT shall be completed only when all items in the checklist have been witnessed and installed by the Contract Administrator/Project Manager, Consultant and CoT-IT as being in conformance with the design as specified.
- SAT of Equipment Room / Telecom Room
 - Each facility shall have one or more equipment room / telecom room, which house the server and network core closets. Each equipment / telecom room shall undergo a witnessed SAT.
 - The Consultant is responsible for the equipment / telecom room UPS, lighting panel and any ER/TR modifications noted in the tender drawings and specifications. The extent of ER/TR modifications varies for each facility.
 - In addition to the above, the ER/TR SAT shall include the evaluation of the server and core closet installation, power supplies to each closet and external cable management (e.g. cable tray). For the purpose of the ER/TR SAT the server and core closets shall be empty except for the installation of duplex receptacles to receive the UPS.
- SAT of Telecom Enclosure
 - As a minimum, the complete Telecom Enclosure for the SAT shall include the installation of copper patch panels, fibre patch panel, power supplies, horizontal cable terminations, cable management and patch cords.
 - At each facility, the Contractor shall provide one complete telecom enclosure, associated accessories and horizontal cable for the SAT. Following acceptance, the Contractor will be directed to proceed with the installation of the remaining TEs and horizontal cabling. The Contractor is to note that the fibre optic backbone cable installation will be included in the core closet SAT.

- The City reserves the right to do a random inspection of the telecom enclosure and those that do not comply with the above shall be made compliant at no expense to the City.

FIELD SUPPORT

- Provide 160 hours of on-site support for each facility beginning immediately after successful site acceptance test at that facility for a period of 24 months following Substantial Performance.
- Respond within 24 hours to a request for on-site support.
- The minimum site time per support call will be four (4) hours.
- The cost for the on-site field support shall be paid based on the rates quoted in the Schedule of Prices.

MAINTENANCE

- For a period of twelve (12) months following Final Acceptance, the Contractor shall provide a qualified technician/electrician to assist in the resolution of network related problems. The Contractor shall be given twenty-four (24) hours notice as to their requirement on-site.
- The Contractor will be compensated at the per diem rate quoted by the Contractor in the Form of Tender. However, if the source of the problem is discovered to be a result of work or components supplied by the Contractor, the Contractor shall not be compensated.

WARRANTY

- Testing and certification of the Building Network Distribution Cabling System shall be by the installer and shall include the provision of a Belden Warranty covering performance, products and installation.
- The Warranty shall cover the full repair and/or replacement of any component failing or failure to meet the design requirements within one (1) year.
- Warranty shall be delivered by the Contractor in coordination with Belden to the Client's Project Manager with the Testing and Certification documents. The project site shall receive manufacturer's plaque. All coordination regarding warranty and handing over of the manufacturer's plaque is the responsibility of the Contractor.

- The manufacturer shall warrant the project for twenty-five (25) years against application assurance and extended product manufacturing defects.
- The Contractor shall warrant installation against all product installation defects and that all approved cabling components meet or exceed the specified requirements for a period of twenty-five (25) years following acceptance.
- The Contractor shall warrant that all permanent fibre optic links meet or exceed the performance requirements of TIA-568.3 for multimode and singlemode fibre.
- The Contractor shall warrant that all permanent twisted pair links meet or exceed the performance requirement of TIA-568.2 for category 6/6A, unshielded twisted pair.
- Contractor must provide complete end to end mapping of all connectivity at the end in both hard and softcopy formats. This includes but not limited to horizontal data / voice cable number, copper and fibre backbone cable and active equipment ports.
- Within ten (10) days after testing, the cable installer shall provide the Project Manager with documentation, which shall include cable test results, a marked-up copy of the as-built cable network drawing and an electronic copy of the completed installation in Bentley Microstation Ver. 8 and AutoCAD or as per City's CAD guidelines.
- Contractor shall provide a manufacturer written certificate, plaque and warranty that the structured cabling platform is installed and fully operating in accordance with this standard and manufacturers specification.
- The warranty must guarantee that the design or installation negligence on the part of the Cabling Contractor shall not negate or void any portion of the certified system. The manufacturer must guarantee that all material, components and labour are covered in this circumstance for the full certification period of twenty-five (25) years. It must also guarantee that in the event a Cabling Contractor is no longer able to service the warranty, the full certification remains valid and is responsibility of the manufacturer.
- If a warranty issue arises for the cabling, the Warrantor must make arrangements to undertake the repair or replacement of warranty issues within 24 hours of notification. This may require the repair/replace of cabling components outside regular working hours at no additional cost.
- The warranty for the cabling must be such that the cable meets or exceeds the requirements of TIA-568 'Transmission Performance Specifications for 100 Ohm 4-pair Category 6/6A Cabling' including all Standards stated in this Contract.
- The Cabling Contractor shall forward the Structured Cabling Platform certification request form(s) to the proper authority and ensure that a Plaque and Certificate is issued to the Customer / Project Site along with the Structured Cabling Platform user manual. The successful bidder shall provide a certification number within two weeks of award of this project. Please

note that the Plaque/Certificate must have the Customer name/Project name on the Plaque/Certificate.

- The Cabling Contractor shall provide letter(s) of Certification within two weeks of substantial completion of the project to the Customer. This document will include the following: verification of the performance of the installed system, identification of the installation by location and project number and a copy of the warranty.
- Upon request and at no additional cost to the Customer the Cabling Contractor must provide a manufacturer's technical representative to conduct an on-site visit to ensure complete technical compliance.
- The Cabling Contractor must supply a copy of an unexecuted warranty statement (at the time of bidding) including all related terms and conditions. This copy shall be the Standard to which the warranty will be held. No changes shall be accepted unless it is deemed to benefit the Customer. Any proposed changes to the warranty must be submitted in writing to the Customer/their representative for review. The changes will then be accepted or declined by the Customer at their discretion. This is to remain valid for the entire warranty period.
- All cable Cabling Contractor technicians on site must be trained by the manufacturer of the Structured Cabling Platform being installed.
- Any defective or improperly installed products shall be replaced, or correctly reinstalled at no cost to the Customer.

QUALIFICATIONS AND TRAINING

- An on-site training may be required for the Client to understand the system and installation.
- Contractors shall be certified with Belden and Fluke Networks to perform installations and testing.
- Contractors must have an RCDD installation Project Manager.
- Technicians who have not completed any certification program shall not pull, terminate or otherwise be involved in the installation of the telecommunications physical infrastructure with the exception of bonding to ground.
- Installers performing the testing (SAT, Acceptance, Commissioning, etc.) shall be certified CCTT on Fluke DSX and/or Optifibre OTDR.
- All Fluke credentials shall be submitted to the City during project award process for validation.
- The testing equipment shall be valid and calibrated within one (1) year as per manufacturer specifications.

- The cable installer shall have full working knowledge of cabling low voltage applications such as, but not limited to, Non-Secure Data/Voice communications cabling systems.
- Provide references of the type of installation provided for in this specification.
- Have knowledge of all applicable Telecommunication Standards such as but not limited to: CSA, TIA, IEEE and ANSI.
- Have experience in the installation of pathways and support for horizontal and backbone cabling.
- Be experienced in the installation and testing of telecommunication network cabling system, including the use of a light meter and OTDR.
- Provide proof of being a manufacturer certified installer for all cable network components being installed such as but not limited to cables, connectors and end termination equipment. The use of a non-manufacturer certified installer is not permitted.

AS-BUILT DRAWINGS

- The drawings shall include cable routes and outlet locations.
- Outlet locations shall be identified by their sequential number as defined elsewhere in this document.
- Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.
- For new infrastructure project, the Consultant shall provide the design drawings / tender drawings / floor plans in paper and electronic (Microstation) formats on which as-built construction information can be added.
- For an existing infrastructure upgrade, the Owner may provide floor plans in paper and electronic (Microstation) formats on which as-built construction information can be added.
- These documents shall be modified accordingly by the Telecommunications Contractor to denote as-built information as defined above and returned to the Owner.
- The Contractors shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic (Microstation) form.

FINAL ACCEPTANCE

- Once all work has been completed including all documentation submissions, the City will notify the satisfaction to the Consultant in writing of formal acceptance of the system.
- Consultant must warrant in writing that 100% of the installation meets the design requirements as specified.
- Contractor must warrant in writing that 100% of the installation meets the requirements specified in the tender documents.
- The CoT-IT reserves the right to conduct, using Contractor equipment and labour, a random re-test of up to five (5) percent of the cable plant to confirm documented results. Any failing cabling shall be re-tested and restored to a passing condition. In the event more than two (2) percent of the cable plant fails during re-test, the entire cable plant shall be re-tested and restored to a passing condition at no additional cost to the Owner.
- Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating and receipt of full documentation as specified.
- The City may agree to allow certain cable runs to exceed acceptable standardized performance criteria. If required these cable runs will be exempt from meeting the specified standards. However, the Contractor will still be required to test these cable runs to validate component and installation performance.
- Documentation: The Contractor shall submit the following documentation for final acceptance:
 - City of Toronto - IT Network — Cable Test Results Manual.
 - Cable Acceptance Test (CAT) – Compliance Sheet
 - Site Acceptance Test (SAT)
 - As-built Drawings and Documents (ADD)
 - Consultant Review and Comments (CRC)
 - CoT-IT Approval of Satisfaction (AoS) – Signing off

APPENDIX-A: SAMPLE OF CABLE ACCEPTANCE TEST (CAT)



CITY OF TORONTO - CABLE TEST RESULTS COMPLIANCE SHEET

Project Name		Contract/Project Number	
Facility Name		Facility Address	
Location		Closet/Rack Number	
Consultant		Contractor	
Original Submission Date	Second Submission Date	Third Submission Date	Fourth Submission Date
City Reviewer	Date Issued	Status <input type="checkbox"/> Approved <input type="checkbox"/> Disapproved	

General

No.	GENERAL	Comply	Does Not Comply	Not Applicable
1	Cable test equipment DSX-5000 / 8000 with latest software version			
2	Cable test equipment DSX-5000 / 8000 with latest limit version			
3	Calibration certificate of the cable test equipment provided to the City			
4	Cable test results supplied to the City in PDF and Native format			
5	Test result specify the project name and / or contract number			
6	Test result specify site name or facility code			

Copper Test Results

No.	COPPER	Comply	Does Not Comply	Not Applicable
1	Permanent link testing performed			
2	Patch cord testing performed			
3	Test result cable identification in compliance with CoT-IT Standard			
4	Test result cable type in compliance with CoT-IT Standard – TIA-568 Horizontal			

Fiberoptics Test Results

No.	FIBRE	Comply	Does Not Comply	Not Applicable
1	Test results based on LED/VCSEL for OM4 50/125 um MM fibre cabling			
2	Test results based on FP Laser for OS2 9/125 um SM fibre cabling			
3	MM testing at 850nm and 1300nm modal bandwidth			
4	SM testing at 1310nm and 1550nm modal bandwidth			
5	Test result cable identification in compliance with City of Toronto-IT Standard			
6	Test result cable type in compliance with City of Toronto-IT Standard and TIA-568 Backbone MM/SM			
7	Test link attenuation in accordance with TIA-526-14 or TIA-526-7 makes reference measurements in accordance with METHOD-B (one jumper cable measurement for MM) or METHOD-A.1 (one jumper cable measurement for SM). Measure optical loss on each fibre at 850nm and 1300nm (for MM) or 1310nm and 1550nm (for SM).			
8	Measure loss on each fibre from each direction (bi-directionally) as per CoT-IT Standard			
9	Accurate quantity of adapter and splices			
10	Smart Remote mode used for testing dual-fibre strands			

**Cable ID: CCTV-MZ/02/01/020**

Test Limit: TIA Cat 6A Perm. Link

Limits Version: V7.6

Date / Time: 06/06/2022 04:38:25 PM

Operator:

Headroom 3.3 dB (NEXT 3,6-7,8)

Cable Type: Cat 6A U/UTP

NVP: 68.2%

Main: Versiv

S/N: 2790064

Software Version: V6.6 Build 2

Calibration Date: 01/31/2022

Adapter: DSX-5000 (DSX-PLA004)

S/N: 4710039

Test Summary: PASS

Remote: Versiv

S/N: 2797296

Software Version: V6.6 Build 2

Calibration Date: 01/31/2022

Adapter: DSX-5000R (DSX-PLA004)

S/N: 4710040

Length (ft), Limit 295	[Pair 7,8]	189
Prop. Delay (ns), Limit 498	[Pair 4,5]	295
Delay Skew (ns), Limit 44	[Pair 4,5]	13
Resistance (ohms)	[Pair 4,5]	9.09
Insertion Loss Margin (dB)	[Pair 3,6]	17.4
Frequency (MHz)	[Pair 3,6]	497.0
Limit (dB)	[Pair 3,6]	43.6

Worst Case Margin Worst Case Value

PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-7,8	3,6-4,5
NEXT (dB)	3.3	6.1	3.3	6.4
Freq. (MHz)	410.0	406.0	410.0	497.0
Limit (dB)	29.5	29.6	29.5	26.7
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	4.6	5.5	6.4	7.0
Freq. (MHz)	410.0	424.0	500.0	497.0
Limit (dB)	26.7	26.2	23.8	23.8

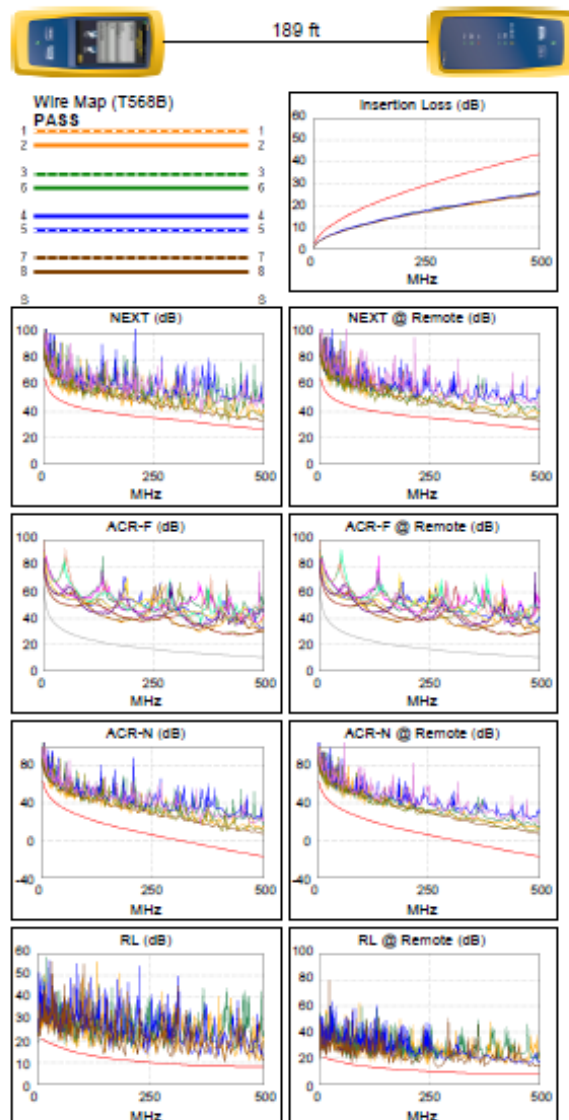
PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	15.7	15.9	15.7	15.9
Freq. (MHz)	441.0	450.0	441.0	450.0
Limit (dB)	11.3	11.1	11.3	11.1
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	16.9	16.4	18.4	17.8
Freq. (MHz)	1.1	1.3	463.0	453.0
Limit (dB)	60.2	59.3	7.9	8.1

N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	3,6-4,5	3,6-4,5
ACR-N (dB)	10.6	12.2	24.0	23.8
Freq. (MHz)	17.4	17.4	500.0	497.0
Limit (dB)	46.8	46.8	-17.1	-16.9
Worst Pair	3,6	1,2	3,6	3,6
PS ACR-N (dB)	11.8	13.7	24.1	24.3
Freq. (MHz)	19.3	17.3	500.0	497.0
Limit (dB)	43.3	44.4	-20.0	-19.7

PASS	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	7,8
RL (dB)	1.9	3.5	2.0	5.0
Freq. (MHz)	146.5	274.0	357.0	481.0
Limit (dB)	12.3	9.6	8.5	8.0

Compliant Network Standards:

10GBASE-T	100BASE-TX	100BASE-T4
1000BASE-T	2.5GBASE-T	5GBASE-T
10GBASE-T	ATM-25	ATM-51
ATM-155	100VG-AnyLan	TR-4
TR-16 Active	TR-16 Passive	



LinkWare™ PC Version 10.5

Project: New Project
Test Results - 00048531.flw

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**Cable ID: 024**

Date / Time: 02/15/2022 09:45:58 AM
Cable Type: SMF G652D

n = 1.467000 (1310 nm)
n = 1.468000 (1550 nm)

Test Summary: PASS

Backscatter Coefficient: -79.4dB (1310 nm)
Backscatter Coefficient: -81.7dB (1550 nm)

**Loss (R->M)
PASS**

Test Limit: ISO/IEC 14763-3
Limits Version: 7.6
Date / Time: 02/15/2022 09:45:58 AM
Operator: JOHN
Main: Versiv
S/N: 21123084
Software Version: V5.7 Build 1
Module: CertiFiber Pro (CFP-QUAD)
S/N: 21212667
Calibration Start Date: 08/12/2021
Remote: Versiv
S/N: 21120065
Software Version: V5.7 Build 1
Module: CertiFiber Pro Remote (CFP-QUAD)
S/N: 21212670
Calibration Start Date: 08/12/2021

Propagation Delay (ns)	7887	
Length ft	5284	PASS
Limit 16404		
	1310 nm	1550 nm
Result	PASS	PASS
Loss (dB)	0.78	0.52
Limit (dB)	3.21	3.21
Margin (dB)	2.43	2.69
Reference (dBm)	-4.04	-4.00

Number of Adapters: 2
Number of Splices: 2
Connector Type: LC
Patch Length1 (ft): 7
Reference Date: 02/15/2022 08:55:51 AM
1 Jumper

**Loss (M->R)
PASS**

Test Limit:
Limits Version:
Date / Time:

	1310 nm	1550 nm
Result	PASS	PASS
Loss (dB)	0.46	0.32
Limit (dB)	3.21	3.21
Margin (dB)	2.75	2.89
Reference (dBm)	-3.07	-3.05

Compliant Network Standards:

100GBASE-LX	100GBASE-ER4	100GBASE-LR4
10GBASE-E	10GBASE-L	10GBASE-LX4
40GBASE-ER4	40GBASE-LR4	Fibre Channel 100-GM-LC-L
Fibre Channel 1200-GM-LC-L	Fibre Channel 1600-GM-LC-L	Fibre Channel 200-GM-LC-L
Fibre Channel 400-GM-LC-L	Fibre Channel 400-GM-LC-M	Fibre Channel 800-GM-LC-L

LinkWare™ PC Version 10.5

Project:
Test Results - 00045277.flw

Page 3



APPENDIX-B: SAMPLE OF SITE ACCEPTANCE TEST (SAT) DOCUMENTS

Checklist of Telecom Enclosure (TE) / Network / Core Closet Site Acceptance Test (SAT)

Facility:	Project Name:
Contract No.:	Telecom Enclosure / Network / Core Closet Tag:
Building:	Sub-Location:
Consultant:	Contractor:
Date:	CoT-IT Staff:

TELECOM ENCLOSURE (TE) / NETWORK / CORE CLOSET LAYOUT AND AS-BUILT DRAWINGS**Procedure:**

- Verify that the as-built drawings are present.
- Verify the Telecom Enclosure components match the bill of materials.
- Verify equipment layout is as shown in the as-built drawings.
- Verify all components are tagged and wiring is labeled as per the drawings. (Enclosure, Patch Panels, Copper Patch Panel(s) Work Area Outlets, Cables, Power Distribution Components, etc.)
- Verify the horizontal and backbone fibre cable terminations and labeling.

If any comments are necessary, enter a note number in the test form column and record the comment in the comments form at the end of this document.

Acceptance Criteria:

Telecom Enclosure construction and labeling shall match the as-built drawings.

As Built Drawings Verification			
Item No.	Description	Pass/Fail	Notes
1	As built drawings present		
2	Bill of materials in compliance		
3	Layout / arrangement of components in compliance		
4	All components tagged as per as-built drawings. (Enclosure, Patch Panels, Copper Patch Panel(s) Work Area Outlets, Power Distribution Components, etc.)		
5	All wiring labeled as per as-built drawings		

Power and Fusing Verification**Procedure:**

Verify that the indicated circuit breakers or fuses are installed and labeled with the indicated rating and source and destination distribution panel, breaker position ID. Refer to as built Telecom Enclosure wiring diagrams for the required circuit protection and rating. Record the installed protection device rating.

If the indicated installed circuit protection device matches the required rating enter PASS in the test form column.

If any comments are necessary, enter a note number in the test form column and record the comment in the comments form at the end of this document.

Acceptance Criteria:

Installed fuses and circuit breakers shall match the required specifications and labeled accordingly. The correct equipment is powered by the fuse and/or circuit breaker as shown on the as-built electrical drawings.

TE AC Power, Fusing and Tagging/Labeling Verification						
Circuit Breaker / Fuse ID	Description	Required Rating	Installed Rating	Pass / Fail	Source / Destination ID	Notes
120V AC UPS Power Supplementary Protectors						
SP02	UPS Receptacle and UPS Pilot Light (if applicable)	15A				
120V AC Hydro Power Supplementary Protectors						
SP01	Surge Suppressor and Utility Pilot Light (if applicable)	15A				
SP03	Panel Light	5A				
SP04	Utility Receptacle	15A				

Grounding & Bonding Verification**Procedure:**

Verify that the indicated component is properly connected to the ground.

- Switch off system power.
- Verify the installation of the ground connection between the grounding bus or common ground terminal and the indicated component.
- Measure the DC resistance between the grounding bus or common ground terminal and the indicated component.
- Record the measured DC resistance between the ground connection and the component.

If the indicated grounding connection is installed and meets the maximum DC resistance specification enter a PASS in the test form column. If any comments are necessary, enter a note number in the test form column and record the comment in the comments form at the end of this document.

Acceptance Criteria:

The grounding or bonding conductor is installed and the DC resistance measurement must be less than or equal to 0.2 Ω between termination points.

Telecom Enclosure (TE) Grounding & Bonding Verification				
Grounding / Termination Point	Ground Conductor Visual Inspection	Resistance Ω Measured	Pass / Fail	Notes
Surge Suppressor		Ω		
UPS Receptacle / Isolated Ground		Ω		
Utility Receptacle		Ω		
Enclosure Door		Ω		
APC Power Bar		Ω		
Rack Mount Ground Bus		Ω		

Spare Parts, Loose Shipped Components, TE - Bill of Material Verification**Procedure:**

Verify all spare parts and loose shipped components as required in the as-built drawings and bill of material are present. Typical items may be Fiber Optic Patch Cables, Copper Patch Cables, etc.

Enter PASS in the test form column if parts are present. If any comments are necessary, enter a note number in the test form column and record the comment in the comments form at the end of this document.

Acceptance Criteria:

Spare parts and loose shipped components are present as required.

Spare Parts and Loose Shipped Items			
Item No.	Description	Pass / Fail	Notes
1	Drawings		
2	Fiber Optic Patch Cords		
3	Copper Patch Cords		
4			
5			
6			
7			
8			
9			
10			

SAT NOTES / COMMENTS

Notes Ref. No.	Notes / Comments

Approvals / Sign Off**Site Acceptance Test****City**

Name : _____ Company: _____

Signature: _____ Date: _____

Consultant

Name : _____ Company: _____

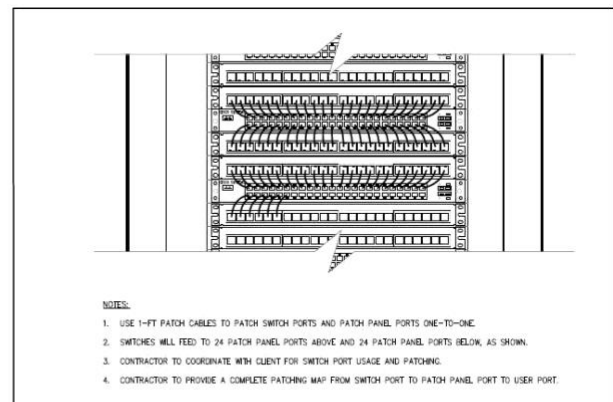
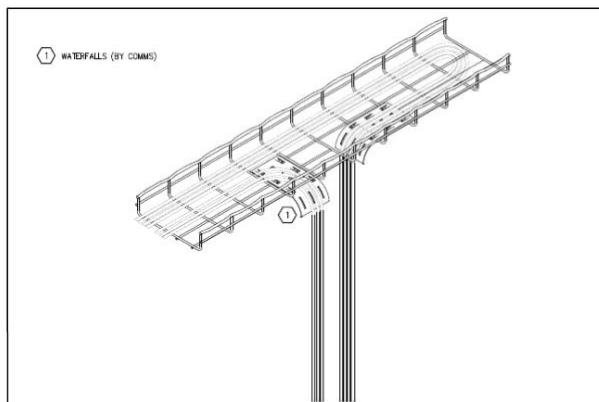
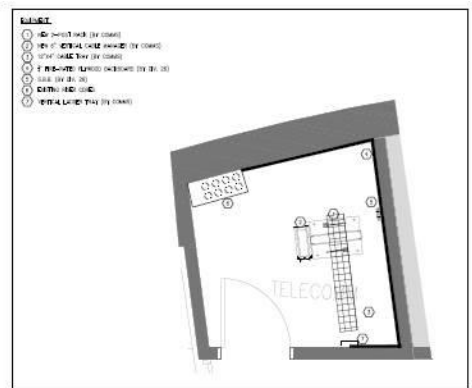
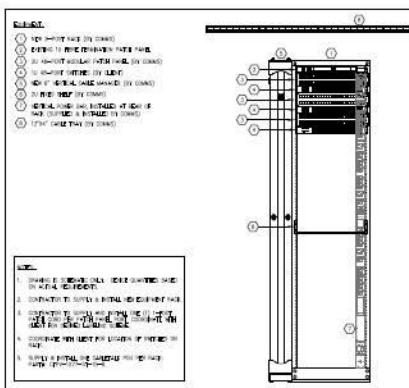
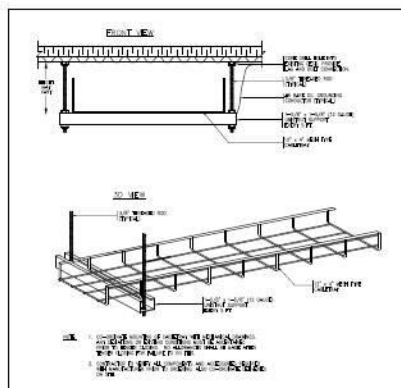
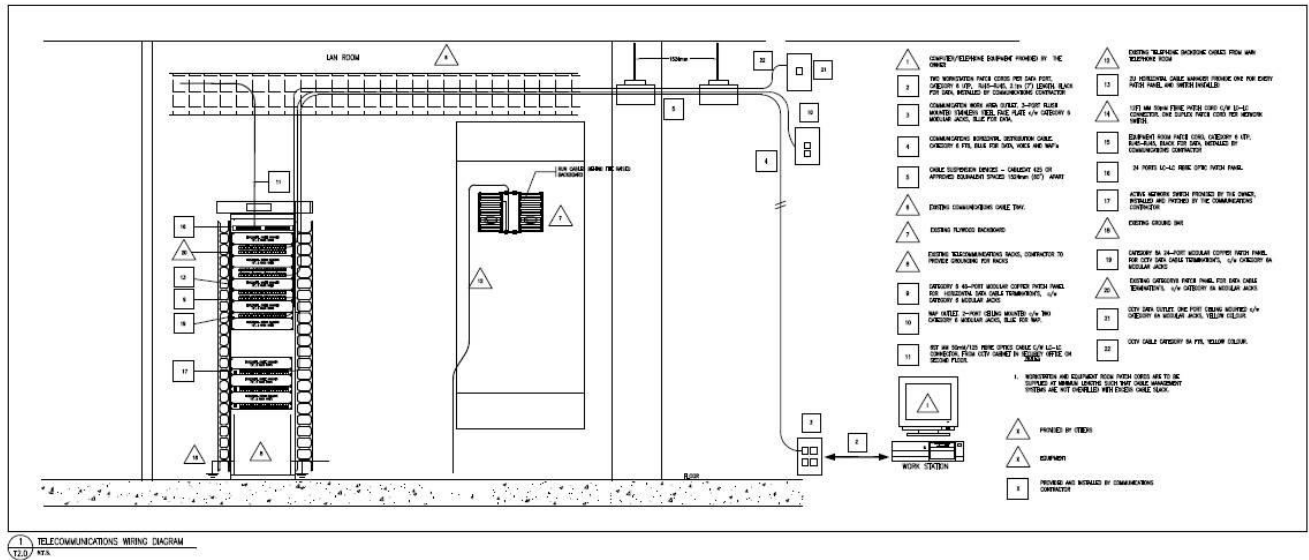
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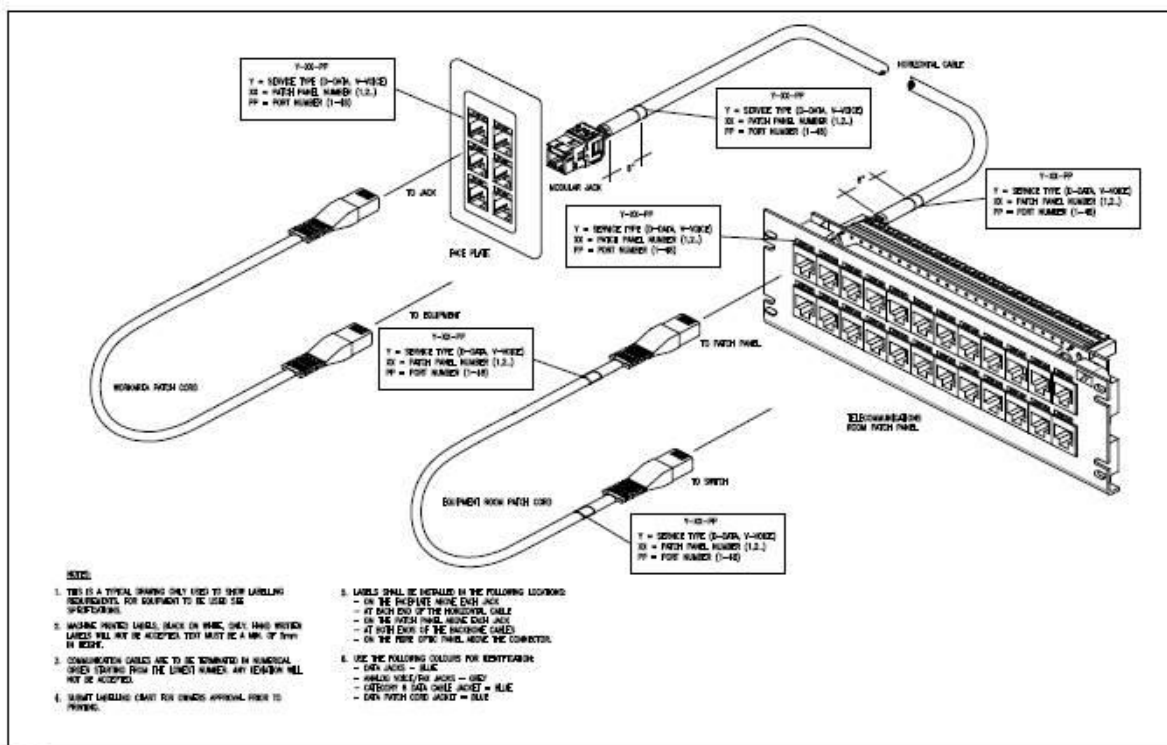
Contractor

Name : _____ Company: _____

Signature: _____ Date: _____

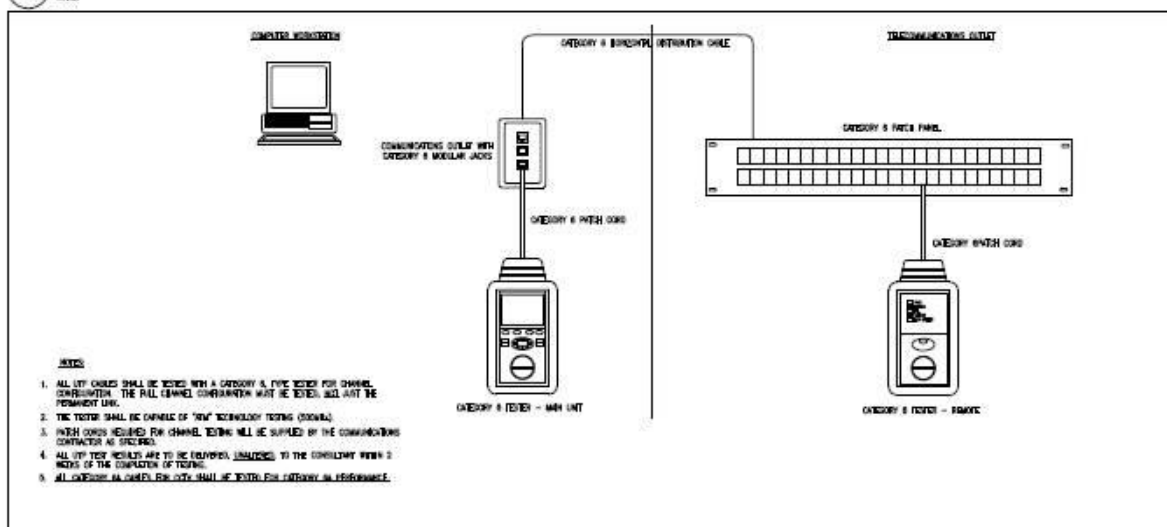
APPENDIX-C: SAMPLE OF TELECOM WIRING DIAGRAMS | DRAWINGS | PHOTOGRAPHS





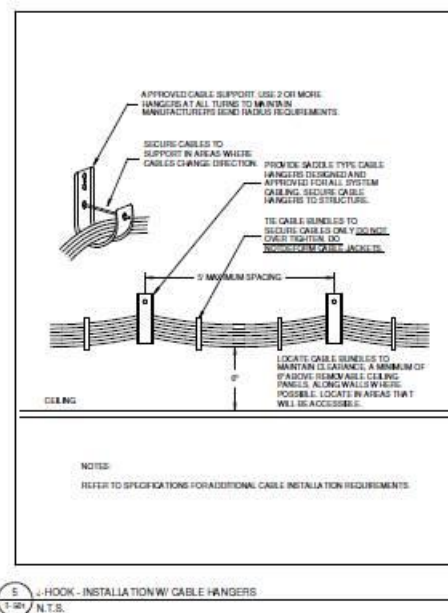
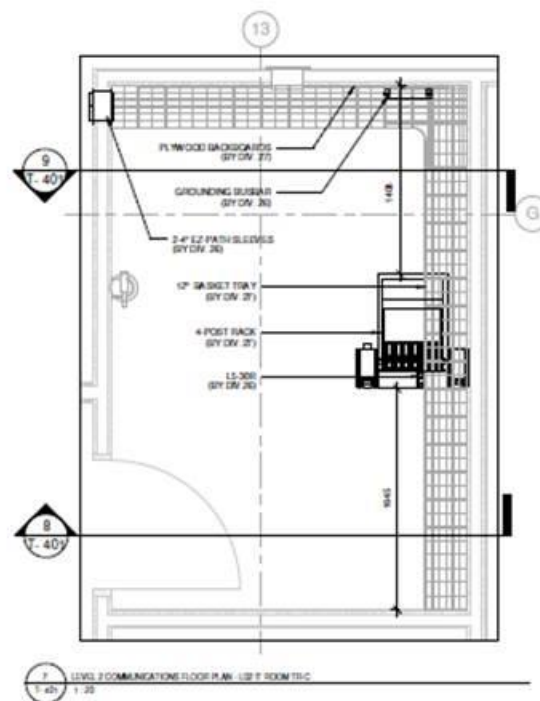
1 COMMUNICATIONS HORIZONTAL CABLE LABELLING
NTS

N.T.S.



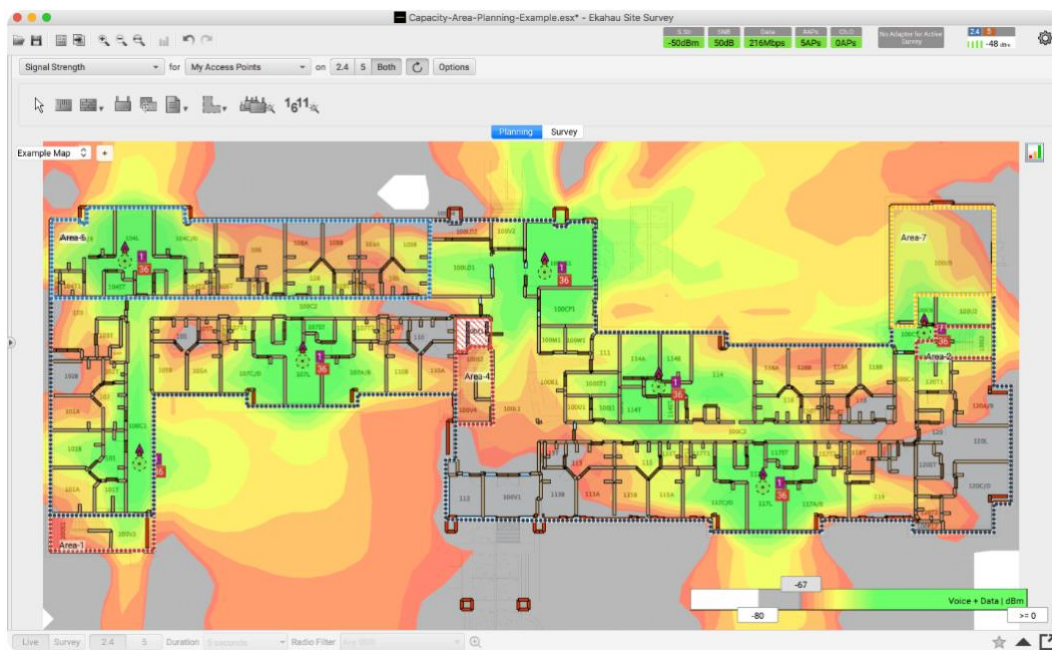
2 CATEGORY 6 UTP CABLE TESTING - TYPICAL
NTS

NTS









WI-FI COVERAGE HEATMAP – EXAMPLE (EKAHAU)

END OF DOCUMENT