

Date: February 21, 2024

(996 pages)

Addendum No. 1**Request for Proposal Call No. NRFP2024-027
CONSTRUCTION OF CENTURY GARDENS YOUTH HUB**

This Addendum forms part of the Bid/Proposal Document.

1. Pertaining to Cash Allowance

The total amount of the Cash Allowance has been revised to \$1,300,000.00.

2. Pertaining to Part A Special Provisions to Instructions to Bidders

ADD SP2. Request for Approval of Alternates

Request for approval of alternates will not be accepted during the bidding period.

3. Pertaining to Specifications

Refer to the Consultant's Addendum 1 as attached (991 pages).

4. **Questions and Answers**

Question 1:

If any mandatory subtrades/suppliers for this tender?

Answer 1:

There is not any mandatory subtrades/suppliers for this project.

Question 2:

At the time of bid submission, are the bidders required to submit an agreement to bond?

Answer 2:

This is a negotiable request for proposal. The agreement to bond is not required to be submitted with the bid submission.

Question 3:

The specifications contain section 09 65 66 Resilient Athletic Flooring with RAF-1 and 2 being Dinoflex Sport Mat. However, in the drawings Finish Schedule and Plan, I don't see this material noted. Can you confirm with the architect whether this material is actually needed for this project and, if so, where it is to go?

Answer 3:

RAF1 and RAF2 is being used as a finish. The locations are indicated on the millwork drawings refer to A900 series.

Question 4:

As per Specification Division 32 37 00 2.2.3 Lounge Chair products, however we are unable to find in the Landscape drawings. Could you please confirm?

Answer 4:

Section 32 37 00 Part 2.3 is Titled "Picnic Table and Bench" which correlates to detail 4/L5.01 titled "Picnic Table & Bench (FFE). The Picnic Table and Bench Lounge chair is in the project scope and is an FFE item to be covered by Cash Allowance.

Question 5:

- 1.) ACMU1:Section 04 22 23-Item # 2.2.3.2 -Please advise where is 190x90x390mm required.
- 2.)Wall Type WF10/WF10.1-specify 90 Architectural block to footing level ,do you require all Architectural block below level 1 or just 90mm Regular Block since it will not be expose and just the 2 coarses of MA5 =90x90x390mm are the Architectural block, please advise.
- 3.) Interior Elevations 2 & 5/A503 both show Brick masonry, while wall type PM11 only show brick on east side of Vestibule 1001, please advise.
- 4.) Plan 5/A381 show CMU1 Back-up @ Foundation, while Structural show Foundation wall type FW200R, please advise.
- 5.) Sections (2,3&4/A315), (1&2/A316), (2/A317),(1,2&3/A323) -shows Block Foundation, while Structural show Foundation wall type FW200/FW200R,please advise.

Answer 5:

- 1.) Sizes to read (high x wide x long), 90mm High block to be used at above grade locations. Refer to keynote MA5 on section details.
- 2.) Refer to Section details and assembly descriptions. As indicated, 190 high block to be used below grade, 90mm block to be used at above grade locations – typical.
- 3.) PM11 is only on the inside face of the Vestibule, 2/A503 should show GWB painted.
- 4.) Foundation makeup to be as per structural documents.

5.) Foundation wall construction to be as per structural documents.

Question 6:

Food Equipment spec seems generic, can you confirm commercial or residential appliances?

Answer 6:

Equipment models and types are fully described in the specification.

Question 7:

Drawing 1/A400 shows IWVS-1, please clarify if this is a millwork item? or it's a prefabricated units by a specific supplier?

Answer 7:

IWVS-1 is noted in the keynote legend as INTEGRATED WASHROOM VANITY SYSTEM and listed in the Specification in section 06 41 00 Integrated Washroom Vanity System.

Question 8:

Question regarding Food Service Equipment scope, please clarify if work tables/stainless steel countertop/sinks are part of food service equipment vendor's scope or millwork scope?

Answer 8:

Millwork is the attach-to-building items like counter tops, which should be included in the base bid. Food service equipment such as mobile tables and food storage equipment is part of Kitchen equipment, to be covered by Cash Allowance.

Question 9:

Is there an established Bid Validity or Bid Irrevocability??

Answer 9:

This is a negotiable request for proposal. No bid validity and irrevocability is applicable.

All other terms & conditions remain unchanged.

If you have any questions, please do not hesitate to contact the undersigned.

Bidders are required to acknowledge all Addenda.

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Addendum 1

1. GENERAL

- .1 This Addendum shall be attached to the front of the specifications and shall be brought to the attention of all concerned.
- .2 This Addendum shall form an integral part and shall be read in conjunction with Specifications and Drawings for the Century Gardens Community Youth Hub. This Addendum shall take precedence over all requirements to the aforementioned specifications with which it may prove to be at variance.
- .3 Receipt of this Addendum shall be acknowledged on the Bid Form. Failure to do so may subject the Proponent to disqualification
- .4 This Addendum Contains:

- .1 Addendum A-01

- .1 Includes:

- .1 Architectural Specification sections dated February 12, 2024:

01 21 00	Allowances
03 35 03	Polished Concrete
03 53 00	Concrete Leveller
07 21 00	Thermal Insulation
07 52 16	SBS Modified Bituminous Membrane Roofing
07 62 00	Metal Flashing

- .2 Structural Specification sections dated February 12, 2024:

03 20 00	Concrete Reinforcement
03 30 00	Cast-in-Place Concrete
05 12 00	Cast-in-Place Concrete
06 18 00	Glue Laminated Timber

- .3 Mechanical and Electrical Specifications dated February 12, 2024

- .4 LEED Specification sections dated February 12, 2024:

01 35 18	LEED Certification Requirements
01 35 18A	LEED Scorecard
01 60 13	LEED Product Requirements
01 81 19	IAQ Management

ADDENDUM A-01

1. ARCHITECTURAL REVISIONS AND CLARIFICATIONS

. 1 Architectural Specifications

Section 01 21 00 Allowances

- .1 **Revise** paragraph 1.2.8.1 List of Cash allowances as indicated

Section 03 35 03 Polished Concrete

- .1 **Revise** paragraph 2.5.3.2.1 as indicated

Section 03 53 00 Concrete Leveller

- .1 **Revise** paragraph 2.2.1.2.1 as indicated

Section 07 21 00 Thermal Insulation

- .1 **Revise** paragraph 1.1.2.1 as indicated

Section 07 52 16 Styrene- Butadiene -Styrene (SBS) Modified Bituminous Membrane Roofing

- .1 **Revise** paragraph 1.2.1. Warranty Confirmation as indicated
- .2 **Delete** paragraph 1.5.1.2.1

Section 07 62 00 Metal Flashing

- .1 **Delete** paragraph 1.3.1.1.1

2. REVISIONS AND CLARIFICATIONS

.1 Structural Specifications

Section 03 20 00 Concrete Reinforcement

- .1 **Revise** paragraph 1.6.2.1 as indicated

Section 03 30 00 Cast-in-Place Concrete

- .1 **Revise** paragraph 1.1.4.5 as indicated

- .2 **Delete** paragraph 1.6.1.8 Integral Crystalline Waterproofing

Section 05 12 00 Cast-in-Place Concrete

- .1 **Revise** paragraph 3.4.10.5 as indicated
- .2 **Delete** paragraph 1.7.11

Section 06 18 00 Glue Laminated Timber

- .1 **Delete** paragraph 3.2.13.3

.2 Mechanical & Electrical Specifications

Section 21 05 00 Mechanical General Requirements

- .1 **Revise** paragraph 1.2.3 as indicated
- .2 **Revise** paragraph 1.9.1 as indicated
- .3 **Revise** paragraph 1.10.2.5 as indicated
- .4 **Revise** paragraph 1.10.4 as indicated
- .5 **Revise** paragraph 1.10.6 as indicated

Section 23 08 13 Start-Up & Performance testing

- .1 **Revise** paragraphs 3.4, 3.5, and 3.6 as indicated

Section 23 21 14 Hydronic Specialties

- .1 **Revise** paragraph 1.2.1 as indicated

Section 23 21 23 HVAC Pumps

- .1 **Revise** paragraph 1.2.2 & 1.2.4 as indicated

Section 23 25 00 HVAC Water Treatment

- .1 **Revise** paragraph 1.2.1 as indicated

Section 23 34 00 HVAC Fans

- .1 **Revise** paragraph 1.2.1 & 1.2.3 as indicated

Section 23 34 33 Air Curtains

- .1 **DELETE** paragraph 1.2.3

Section 23 81 40 Heat Pumps

- .1 **Revise** paragraph 1.2.4 as indicated
- .2 **Revise** paragraph 1.2.5 as indicated

Section 25 01 11 Commissioning

- .1 **Revise** paragraphs 3.8.2 & 3.8.3 as indicated

Section 25 90 00 Building Automation System

- .1 **Delete** paragraphs 2.7.1 through 2.7.10 as indicated
- .2 **Revise** Paragraph 2.10.11 as indicated

Section 26 27 29 Electric Vehicle Charging Station

- .1 **Revise** paragraph 2.2.7 as indicated

Section 26 54 00 Lighting Control System

- .1 **Revise** paragraph 2.1.2 as indicated

Section 27 41 16 Integrated Audio-Visual System

- .1 **Revise** paragraph 1.5.5 as indicated
- .2 **Delete** paragraph 1.7

Section 27 51 16 PAVA & BGM System

- .1 **Delete** Paragraph 1.11.2

.3 LEED Specifications

Section 01 35 18 LEED Certification Requirements

- .1 **Revise** paragraph 1.1.1 as indicated

Section 01 35 18A LEED Scorecard

- .1 **Revised** as indicated

Section 01 60 13 LEED Product Requirements

.1 **Revise** paragraph 4.2.2 as indicated

Section 01 81 19 IAQ Management

.1 **Revise** paragraph 1.2.2 as indicated

END OF ADDENDUM A-01

Allowances

Revised by Addendum No.1

PART 1 - GENERAL

1.1 Section Includes

- .1 Cash allowances.

1.2 Cash Allowances

- .1 Expenditure of cash allowances:
 - .1 The *Owner*, through the *Consultant*, will provide the *Contractor* with documentation required to permit pricing of a cash allowance item.
 - .2 The *Owner*, through the *Consultant*, may request the *Contractor* to disclose originals of all bids, quotations, and other price-related information received from potential *Suppliers* or *Subcontractors*.
 - .3 The *Owner*, through the *Consultant*, will determine by whom each cash allowance item will be performed and for what amount. Obtain *Owner's* prior written approval in the form of a *Change Order* before entering into a subcontract, amending an existing subcontract, or before performing by own forces, work that is covered by a cash allowance. Upon issuance of the *Change Order*, the *Contractor's* responsibilities for a cash allowance item shall be the same as for other work of the *Contract*.
- .2 Cash allowances are for supply and installation unless otherwise specified.
- .3 Amount of each cash allowance does not include *Contractor's* overhead and profit, and other related costs, which shall be included in the *Contract Price* and not in the cash allowance.
- .4 Cash allowances for supply only:
 - .1 Amount of each cash allowance includes:
 - .1 Cost of *Products* as invoiced by the *Supplier*, including delivery and applicable taxes but excluding Value Added Taxes.
 - .2 Amount of each cash allowance does not include costs of the following items, which costs shall be included in the *Contract Price* and not in the cash allowance:
 - .1 Unloading, handling and storage at the *Place of the Work*.
 - .2 Installation and all other related costs.
- .5 Cash allowances for install only:
 - .1 Amount of each cash allowance includes:
 - .1 Unloading, storing, handling of *Products* at the *Place of the Work*.
 - .2 Installation, finishing, and commissioning of *Products*.
 - .3 Applicable taxes and duties (excluding Value Added Taxes).
 - .2 Amount of each cash allowance does not include costs of the following items, which costs shall be included in the *Contract Price* and not in the cash allowance:
 - .1 Net cost of *Products*.
 - .2 Delivery to the *Place of the Work*.

Allowances

Revised by Addendum No.1

- .6 Cash allowances for supply and install:
 - .1 Amount of each cash allowance includes:
 - .1 All costs to provide the specified *Products*, including supply, installation, and related costs, excluding Value Added Taxes.
 - .2 *Subcontractor's* and sub-*Subcontractor's* overheads and profits related to the cash allowance.
 - .7 Cash allowances for services:
 - .1 Amount of each cash allowance includes:
 - .1 All costs related to the services, excluding Value Added Taxes.
 - .2 *Subcontractor's* and sub-*Subcontractor's* overheads and profits related to the cash allowance.
 - .8 List of cash allowances
 - .1 The following cash allowances are included in the *Contract Price*:
 - .1 Independent inspection and testing per Section 01 45 00:
~~\$75,000.~~ \$70,000. [Addendum No.1]
 - .2 Air tightness testing: \$40,000.
 - .3 Environmental graphics: \$50,000.
 - .4 FF&E (Furniture, Fixtures, and Equipment): \$700,000.
 - .5 Signage: \$100,000.
 - .6 Audio/Visual: \$50,000.
 - .7 Security: \$90,000.
 - .8 Moss art wall: \$30,000.
 - .9 Hardware: \$70,000.
 - .10 Kitchen equipment: \$100,000. [Addendum No. 1]

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION

PART 1 - GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Polished concrete finish system (PCF1):
 - .1 Surface preparation and grinding.
 - .2 Apply hardener and polish concrete to specified finish.
 - .3 Edge and corner grinding/polishing with hand tools for polished concrete finish at perimeter of structural elements and at concrete curbs.
 - .4 Control joint filler at slab-on-grade locations.

1.2 Administrative Requirements

- .1 Conduct a pre-installation meeting in accordance with Section 01 31 19 and in accordance with Concrete Floor Contractors Association Technical Bulletin entitled "Preconstruction Meetings".
 - .1 Independent inspection and testing company shall attend the pre-installation meeting.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
- .3 Samples:
 - .1 Submit 300 x 300 mm (12" x 12") samples of each specified material and finish, in each specified colour to show successive applications of each coat.
- .4 LEED submittals:
 - .1 Submit LEED submittals in accordance with Section 01 35 18.
 - .2 Submit documentation to verify compliance with LEED objectives and requirements.

1.4 Closeout Submittals

- .1 Submit closeout submittals in accordance with Section 01 77 00.
- .2 Operation and maintenance data:
 - .1 Submit manufacturer's maintenance instructions for incorporation into the operation and maintenance manuals.

1.5 Quality Assurance

- .1 Qualifications:

Polished Concrete

Revised by Addendum No. 1

- .1 Execute the work of this section only by *Subcontractor* who is a member in good standing of the Concrete Floor Contractors Association of Ontario.
- .2 Provide the work of this section, executed by competent installers with minimum 5 years experience in application of *Products*, systems and assemblies specified and with approval and training of *Product* manufacturers.
 - .1 Submit applicator's certification showing applicator's good standing with *Product* manufacturer.
- .2 Mock-ups:
 - .1 Provide 3050 mm x 3050 mm (10' x 10') mock-up at the *Place of the Work* as part of final installation for approval, location to be directed by *Consultant*. Allow for three mock-up areas to determine aggregate exposure classification and polish level.
 - .2 Mock-up shall include edge and corner polished concrete finish at perimeter of structural elements and at concrete curbs and joint filler.

1.6 Delivery, Storage, and Handling

- .1 Store materials at the *Place of the Work* in an area specifically set aside for purpose that is locked, ventilated, and maintained at temperatures of between 16°C and 32°C and in accordance with finish system manufacturer's written requirements.

1.7 Field Conditions

- .1 Comply with polished concrete manufacturer's written requirements for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting work of this section.
- .2 Concrete floor must be level surface to minimum tolerances as follows in accordance with CAN/CSA A23.1/A23.2-14 with no defects:
 - .1 F_F 40.
- .3 Substrate shall be steel trowelled (3 pass), cured for a minimum of 28 days, damp cured a minimum of 7 days following concrete placement, sound, dry, free of dust, dirt, paint, grease, oil, or other foreign substances.
- .4 Provide adequate ventilation during installation.
- .5 Advise other trades of fixtures and fittings not to be installed until floor finish materials are cured.
- .6 Protect adjacent surfaces from damage resulting from work of this section. If necessary, mask and/or cover adjacent surfaces, fixtures, equipment, and the like, by suitable means.

PART 2 - PRODUCTS

2.1 LEED Requirements

- .1 Comply with the requirements of Sections 01 35 18, 01 74 19, 01 81 19, and 01 60 13, as applicable.
- .2 Waste management and disposal:

Polished Concrete

Revised by Addendum No. 1

.1 Comply with the waste management plan developed by the *Contractor* for the *Work* in accordance with Section 01 35 18 and Section 01 74 19. Comply with the directions of the *Contractor's* LEED coordinator with regard to waste management and disposal activities.

.3 Construction indoor air quality (IAQ) management:

.1 Comply with the IAQ management plan developed by the *Contractor* for the *Work* in accordance with Section 01 35 18 and Section 01 81 19. Comply with the directions of the *Contractor's* LEED coordinator with regard to IAQ management activities.

2.2 Design/Performance Requirements

.1 Performance criteria; hardener treated polished 24 MPa concrete:

- .1 Abrasion resistance: ASTM C779/C779M-19, Procedure A, 30 minutes: 0.2 mm (0.008").
- .2 Horizontal floors shall have a Dynamic Coefficient of Friction (DCOF) of 0.48 to ANSI A137.1-2012.
- .3 Absorption: 1.1 ml, 24 hour cumulative absorption per Rilem absorption testing Method No. II.4.

2.3 Polished Concrete

.1 Source quality control:

.1 Source concrete finishing components and materials are from single manufacturer.

.2 Provide polished concrete system as specified herein and conforming to the following requirements:

.1 Aggregate exposure; depth of grind:

.1 Fine aggregate exposure: CFCA Class B.

.2 Finish:

.1 Natural finish.

.3 Polish level:

.1 Level 2; semi-gloss finish.

2.4 Polished Concrete Systems

.1 Acceptable *Products*:

.1 Retroplate Canada 'Retroplate'.

.2 W.R. Meadows 'Induroshine'.

.3 Substitutions: in accordance with Section 01 25 00.

2.5 Polished Concrete Floor Finish Products

.1 Concrete hardener:

.1 Acceptable *Products*:

Polished Concrete

Revised by Addendum No. 1

- .1 Retroplate Canada 'Retro-Plate 99'.
- .2 W.R. Meadows 'Liqui-hard'.
- .3 Substitutions: in accordance with Section 01 25 00.
- .2 Concrete finish enhancer:
 - .1 Acceptable *Products*:
 - .1 Retroplate Canada 'RetroGuard'.
 - .2 W.R. Meadows 'Bellatrix'.
 - .3 Substitutions: in accordance with Section 01 25 00.
 - .3 Control joint (sawcut) filler; at slab-on-grade locations: Semi-rigid, 2-component, self-levelling, 100% solids, rapid curing, polyurea control joint and crack filler with Shore A 80 or higher hardness.
 - .1 Colour: to later selection by *Consultant*.
 - .2 Acceptable *Products*:
 - .1 Euclid Canada 'Euco Qwikjoint 200' or approved equal. [Addendum No.1]
 - .2 Substitutions: in accordance with Section 01 25 00.
- .4 Water: Clean, free oil, soluble salts, or other deleterious substances.

PART 3 - EXECUTION

3.1 Examination

- .1 Verify that specified environmental conditions are ensured before commencing the work of this section.
- .2 Examine surfaces to receive finish system. Concrete surfaces shall be smooth, sound, dry, and free from conditions that will adversely affect execution, permanence, or quality of the work of this section. Test surfaces for moisture content using manufacturer's recommended test procedure to ensure that they are suitable for application, and fully cured.
- .3 Ensure that surfaces have been provided as specified in the work of other sections, that they will not adversely affect execution, permanence, or quality of the work of this section, and that they can be put into acceptable condition by means of preparation specified in this section.
- .4 Concrete slabs shall have sound surface free of dust, chemicals, grease, oil, laitance and curing agents, and cured to requirements of manufacturer of hardening agent.
- .5 Commencement of work shall imply acceptance of surfaces and conditions. Defective work resulting from application to unsatisfactory surfaces will be considered the responsibility of those performing the work of this section.
- .6 If any substrate deficiency is apparent, notify *Contractor* in writing prior to commencing work.
- .7 Site verification of conditions:

Polished Concrete

Revised by Addendum No. 1

- .1 Verify that concrete substrate conditions, which have been previously installed under other sections or contracts, are acceptable for product installation in accordance with manufacturer's requirements prior to installation of concrete finishing materials.
- .8 Verify concrete slab performance requirements:
 - .1 Verify concrete is cured to in accordance with manufactures written requirements.
 - .2 Verify concrete surfaces received a hard steel-trowel finish (3 passes) during placement.
 - .3 Verify overall floor flatness is a minimum of F_F 40.

3.2 Preparation

- .1 After acceptance of surfaces, prepare surfaces as required by the polished concrete manufacturer.
- .2 Cover or mask surfaces adjacent to those receiving finish system to protect work of others and property from damage and soil.
- .3 Grinding and hardening at vertical barriers, perimeter of structural elements and at concrete curbs in accordance with approved mock-up.
- .4 Control joints:
 - .1 Mask each side of sawcut joints before filling joints with joint filler.
 - .2 Apply control joint filler in accordance with joint filler manufacturer's written requirements.

3.3 Installation

- .1 Apply polished concrete finish system in accordance with polished concrete manufacturer's written requirements.
- .2 Grind, polish and harden concrete surfaces to match accepted samples and mock-ups. Match approved samples in sheen, colour and texture.
- .3 Hardening and polishing of concrete surfaces:
 - .1 Application shall not take place until after at least 30 days of placement of concrete.
 - .2 Application is to take place at least 10 days prior to installation of equipment or furnishings, thus providing a complete, uninhibited concrete slab for application
 - .3 Applicable procedures must be followed as recommended by the *Product* manufacturer and as required to match approved test sample.
 - .4 Achieve increased impermeability, hardening, dust-proofing, and abrasion resistance of the surface while imparting a sheen.
 - .5 Apply special concrete hardener finish in accordance with manufacturer's requirements.
- .4 Finish enhancer application:
 - .1 Apply 2 coats of concrete finish enhancer in accordance with manufacturer's requirements. After application of concrete finish enhancer, burnish within 2 hours after the *Products* application.

Polished Concrete

Revised by Addendum No. 1

- .5 Erect barriers to prevent the entry and presence of personnel not performing work of this section during application of hardener/sealer, and for 12 hours following completion of application.

3.4 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.
 - .1 Inspection and testing:
 - .1 Independent inspection and testing company shall verify slip resistance of polished concrete flooring in-situ on mock-up sample.
 - .2 Manufacturer shall provide field review in accordance with Section 01 45 00.

3.5 Adjusting and Cleaning

- .1 Touch up and refinish minor defective work. Refinish entire coated surface areas where finish is damaged or otherwise unacceptable.
- .2 Wash polished concrete surfaces with a neutral cleaner, rinse with clean water and allow to dry.
- .3 Protect polished concrete from staining and damage.
- .4 Final cleaning shall be in accordance with section 01 77 00.

3.6 Protection

- .1 Protect concrete in accordance with Section 01 56 00.

END OF SECTION

PART 1X – GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Levelling concrete topping in locations as indicated, to achieve flush and level floor finishes as follows:
 - .1 Concrete topping (CEM-U1) as levelling underlayment for floor finishes under Division 9.

1.2 Administrative Requirements

- .1 Conduct a pre-installation meeting in accordance with Section 01 31 19.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
 - .2 Submit for approval a list of the system materials intended for use in the *Work* for each condition before installation commences.
- .3 Samples:
 - .1 Submit 3 - 305 mm x 305 mm (12" x 12") samples, on rigid backing, of each specified *Product* system.
- .4 Certificates:
 - .1 Manufacturer's certification that the *Product* is Portland cement-based having an inorganic binder content which is a minimum 80% Portland cement when tested per ASTM C150/C150M-21 - Standard Specification for Portland Cement.
 - .2 Manufacturer's certification that *Product* specified is suitable for intended use when installed in accordance with manufacturer's printed installation instructions.
- .5 Manufacturers' instructions: Submit concrete topping manufacturer's written recommended guidelines with respect to application of topping and finished flooring materials, ventilation and environmental requirements.
- .6 LEED submittals:
 - .1 Submit LEED submittals in accordance with Section 01 35 18.
 - .2 Submit documentation to verify compliance with LEED objectives and requirements.

1.4 Quality Assurance

- .1 Qualifications:
 - .1 Work of this section, executed by competent applicators with minimum 5 years experience in application of *Products* and systems specified and with approval and training of *Product* manufacturer.

Concrete Leveller

Revised by Addendum No.1

- .2 Cooperation: Ensure that concrete supplied for slabs contains no admixtures that would be incompatible with concrete topping.
- .3 Mock-ups:
 - .1 Provide 1830 mm x 2440 mm (6'-0" x 8'-0") area in location as selected by *Consultant*, completely finished for review and acceptance by *Consultant*.

1.5 Delivery, Storage, and Handling

- .1 If materials are stored at the *Place of the Work*, they shall be stored in an area specifically set aside for this purpose that is locked, ventilated, and maintained at minimum temperature of 10°C.
- .2 Materials to be stored in their original, unopened packages.

1.6 Field Conditions

- .1 Building interior shall be enclosed and maintained at a temperature above 10°C until structure and subfloor temperatures are stabilized.
- .2 Ensure substrate is sound, dry, free of dust, dirt, paint, grease, oil or other foreign substances.
- .3 Ensure that voids that would allow the mix to run through the substrate are filled.
- .4 Provide adequate ventilation required during installation.
- .5 Keep other *Subcontractors* from area to be poured during day of pour. Keep heavy work off of topping for at least 2 to 4 hours following pour, in accordance with manufacturer's directions.
- .6 Protect adjacent surfaces from damage resulting from work of this section. If necessary, mask and/or cover adjacent surfaces, fixtures, equipment, and the like by suitable means.
- .7 Concrete substrates are to be cured a minimum of 28 days.

PART 2 – PRODUCTS

2.1 LEED Requirements

- .1 Comply with the requirements of Sections 01 35 18, 01 74 19, 01 81 19, and 01 60 13, as applicable.
- .2 Waste management and disposal:
 - .1 Comply with the waste management plan developed by the *Contractor* for the *Work* in accordance with Section 01 35 18 and Section 01 74 19. Comply with the directions of the *Contractor's* LEED coordinator with regard to waste management and disposal activities.
- .3 Construction indoor air quality (IAQ) management:
 - .1 Comply with the IAQ management plan developed by the *Contractor* for the *Work* in accordance with Section 01 35 18 and Section 01 81 19. Comply with the directions of the *Contractor's* LEED coordinator with regard to IAQ management activities.

Concrete Leveller

Revised by Addendum No.1

2.2 Materials

- .1 Self-levelling concrete topping system:
 - .1 Self-levelling topping system consisting of primer and mix of special cements and binders which, when mixed with water, become highly liquid cement compound that seeks its own level and produces flat, smooth surfaces.
 - .2 Acceptable *Products*:
 - .1 Self-levelling concrete topping system: Ardex Engineered Cements 'ARDEX K-15 Self-Levelling Underlayment Concrete'.
 - .1 Primer: 'ARDEX P-51' or approved equal for standard absorbent concrete, and as recommended by concrete topping manufacturer. [Addendum No.1]
 - .2 Substitutions: in accordance with Section 01 25 00.
 - .3 Compressive strength: 38 MPa (5500 psi) at 28 days, to ASTM C109/C109M-21 (air cure only).
 - .4 Aggregate shall be well graded, washed gravel 3 mm to 6 mm (1/8" to 1/4") or larger for use when underlayment is installed over 38 mm (1-1/2") thickness.
 - .5 Each material used in the application of self-levelling cement-based topping shall be as approved or manufactured by *Supplier* of concrete topping.
 - .6 Thickness: as indicated.
 - .7 Water shall be clean, potable, and sufficiently cool and not warmer than 21°C (70°F).

2.3 Mixing

- .1 Mix in accordance with manufacturer's printed instructions.

PART 3 - EXECUTION

3.1 Examination

- .1 Verify that specified environmental conditions are ensured before commencing work of this section.
- .2 Surfaces to receive flooring finishes shall be smooth, sound, dry, and free from conditions that will adversely affect execution, permanence, or quality of the work of this section and in accordance with manufacturer's printed instructions.
- .3 Defective work resulting from application to unsatisfactory surfaces will be considered the responsibility of those performing the work of this section.

3.2 Preparation

- .1 Cover and protect work of other sections and property from damage and dust.
- .2 Erect barriers to prevent entry and presence of personnel not performing work of this section during application of topping.
- .3 Mechanically roughen and clean substrate, by shot blasting and apply bonding agent in accordance with manufacturer's written instructions.

Concrete Leveller

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3.3 Application - Interior Floors

- .1 Ensure that manufacturer's required conditions have been met at the *Place of the Work* prior to commencing application.
- .2 Prime prepared substrate and apply topping in accordance with manufacturer's printed information.
- .3 Provide concrete levelling material as required to achieve smooth, level and uniform surface for finish flooring materials to thickness as indicated.
- .4 Surface shall be true to plane within ± 3.2 mm in 3000 mm ($\pm 1/8$ in 10 ft) as described in ACI 117-10, straightedge in accordance with CAN/CSA A23.1/A23.2-14.
- .5 Apply leveller with care to ensure that no laps, voids, or other marks or irregularities are visible, and with an appearance of uniform level and texture, within limitations of materials and areas concerned.
- .6 Make clean true junctions with no visible overlap between adjoining applications of topping.
- .7 Do not cover or bridge expansion joints or control joints. Provide 3 mm (1/8") wide sawcut joints over concrete slab control joints.

3.4 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.

3.5 Adjusting and Cleaning

- .1 Remove promptly as work progresses spilled or spattered topping materials from surfaces. Clean floors upon completion of the work of this section.

END OF SECTION

Thermal Insulation

Revised by Addendum No.1

PART 1- GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Thermal insulation types as indicated in Section 07 21 01.
- .2 Section excludes:
 - .1 Roofing insulation: roofing insulation as specified under Section ~~07 56 16~~07 52 16. [Addendum No. 1]
 - .2 Curtainwall insulation: as specified under Section 08 44 00.
 - .3 Acoustic insulation: as specified under Section 09 29 00.

1.2 Administrative Requirements

- .1 Conduct a pre-installation meeting in accordance with Section 01 31 19.
 - .4 Independent inspection and testing company shall attend the pre-installation meeting.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data:
 - .1 Submit manufacturer's *Product* data sheets for *Products* proposed for use in the work of this section.
 - .2 Submit data and installation instructions for materials and prefabricated devices, providing descriptions sufficient for identification at the *Place of the Work*.
 - .3 Submit data from manufacturer's or independent laboratory indicating compatibility and adhesive results of proposed materials.
- .3 LEED submittals:
 - .1 Submit LEED submittals in accordance with Section 01 35 18.
 - .2 Submit documentation to verify compliance with LEED objectives and requirements.

1.4 Quality Assurance

- .1 Qualifications:
 - .1 Execute work of this section using a *Subcontractor* who has adequate plant, equipment and skilled workers to perform it expeditiously, and is known to have been responsible for satisfactory installations similar to that specified during a period of at least the immediate past 5 years.

PART 2- PRODUCTS

2.1 LEED Requirements

- .1 Comply with the requirements of Sections 01 35 18, 01 74 19, 01 81 19, and 01 60 13, as applicable.

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- .2 Waste management and disposal:
 - .1 Comply with the waste management plan developed by the *Contractor* for the *Work* in accordance with Section 01 35 18 and Section 01 74 19. Comply with the directions of the *Contractor's* LEED coordinator with regard to waste management and disposal activities.
- .3 Construction indoor air quality (IAQ) management:
 - .1 Comply with the IAQ management plan developed by the *Contractor* for the *Work* in accordance with Section 01 35 18 and Section 01 81 19. Comply with the directions of the *Contractor's* LEED coordinator with regard to IAQ management activities.

2.2 Insulation Materials

- .1 Read in conjunction with Section 07 21 01.
- .2 INS-12:
 - .1 Rigid insulation board; mineral fibre.
 - .2 Mineral-fibre insulation to CAN/ULC-S702, Type 1, 128 kg/m³ (8 lb/ft³) minimum density to ASTM C612-10, basalt rock and steel slag mineral-fibre insulation.
 - .3 Acceptable *Products*:
 - .1 Rockwool 'Comfortboard 80'.
- .3 INS-21:
 - .1 Semi-rigid insulation board; wood and steel stud type.
 - .2 Non-combustible mineral-fibre to to CAN/ULC S702-14, Type 1, and to CAN/ULC-S114-05, 32 kg/m³ (2 lb/ft³) minimum density to ASTM C167 for basalt rock and steel slag mineral-fibre insulation.
 - .3 Acceptable *Products*:
 - .1 Rockwool' ComfortBatt'.
 - .2 Substitutions: in accordance with Section 01 25 00.
- .4 INS-22:
 - .1 Semi-rigid insulation board; cavity wall type.
 - .2 Mineral-fibre to CAN/ULC S702-14, Type 1.
 - .1 Dual density:
 - .1 Outer layer: 100 kg/m³ (6.25 lb/ft³) to ASTM C612-14.
 - .2 Inner layer: 65 kg/m³ (4.1 lb/ft³) to ASTM C612-14.
 - .2 Mono density:
 - .1 96 kg/m³ (6.0 lb/ft³) to ASTM C612-14.
 - .3 Acceptable *Products*:
 - .1 Johns Manville 'Cladstone Water & Fire Block Insulation – 6.0 PCF'.
 - .2 Owens Corning 'Thermafiber RainBarrier HD'.
 - .3 Rockwool 'CavityRock'.

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- .4 Substitutions: in accordance with Section 01 25 00.
- .5 INS-40:
 - .1 Foamed-in-place (gap filler) insulation.
 - .1 One-component CFC-free polyurethane foam to CAN/ULC S710.1-11.
 - .2 Two-component CFC-free polyurethane foam to CAN/ULC S711.1-11.

2.3 Accessories

- .1 Insulation mechanical fasteners: HDPE washer, zinc plated pin finish, pins purpose made to suit substrate material, 50 mm (2") insulation holding diameter; direct fasten type, washer depth length to suit insulation thickness.
 - .1 *Acceptable Products:*
 - .1 Hilti 'X-IE'.
 - .2 ITW InsulFast Fastener.
 - .2 Adhesive: solvent based polymer modified liquid applied membrane, compatible with substrate and insulation to be applied, type as manufactured for the attachment of insulation.
 - .1 *Acceptable Product:* Bakor Airbloc 21 or 230-21.
- .3 Batt insulation wire mesh restraint; locations where insulation is not sandwiched by sheet metal or board materials: galvanized coated woven wire and mechanical fasteners.

PART 3 - EXECUTION

3.1 Installation – General

- .1 Install insulation in accordance with manufacturer's installation instructions applicable to products and applications indicated.
- .2 Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- .3 Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- .4 Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.
- .5 Install attachment at rate as required to prevent displacement of insulation boards during construction operations.
- .6 Butt joints tightly and offset vertical joints to form an unbroken thermal envelope. Use only insulation boards free from chipped or broken edges. Use largest possible dimensions to reduce number of joints.
- .7 Apply insulation to ensure total and complete coverage of surfaces indicated to be insulated, and in direct contact with such surfaces.
- .8 Ensure integrity and continuity of insulation at juncture with different types of materials and seal in an acceptable manner.

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- .9 Do not cover insulation until it has been reviewed and accepted by *Consultant*.

3.2 Installation – Below-Grade Insulation

- .1 On vertical surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
- .2 On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
- .3 Concrete faced below grade perimeter foundation insulation:
- .1 Install concrete faced insulation using corrosion resistant concrete fasteners and clips, required clips in accordance with manufacturer's written recommendations.
- .2 Extend panels to minimum 150 mm (6") below finished grade unless otherwise indicated.
- .3 Layout concrete faced insulation boards to maximize board sizes. Do not use boards less than 305 mm (12") wide. Orient boards vertically.
- .4 Apply sealant around penetrations in accordance with Section 07 92 00.

3.3 Installation – Rigid Insulation Application

- .1 Mechanically fasten to substrate with minimum of 5 insulation fasteners (dice pattern) per insulation board and maximum spacing of 610 mm (24") on centre.

3.4 Installation – Batt Insulation

- .1 Fit insulation closely around electrical boxes, pipes, ducts, frames and other objects in or passing through insulation.
- .2 Install batt insulation to fill cavity unless otherwise indicated.
- .3 Trim insulation to provide close-fit contact to framing assemblies and fill the required cavity or insulation assemblies to thicknesses specified or indicated.
- .4 Do not over compress or pack insulation to fit into spaces; maintain density to be consistent with the density of the uncompressed batt product.
- .5 Cut insulation to provide close-fit contact around electrical boxes, pipes, and other obstructions and penetrations through and within assemblies.
- .6 Secure insulation in such a manner that it will not sag or settle away from required locations.
- .7 Install continuous woven wire restraint mechanically fastened to steel studs to hold insulation against exterior sheathing materials.
- .8 Place insulation equal to that indicated for applicable assembly in jamb and header assemblies that will be inaccessible after their installation into wall.

3.5 Installation – Semi-Rigid Insulation

- .1 Mechanically fasten to substrate with minimum of 5 insulation fasteners (dice pattern) per insulation board and maximum spacing of 610 mm (24") on centre.

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3.6 Installation – Foamed-in-Place (Gap Filler) Insulation

- .1 Install one-component foam insulation to fill gaps where indicated, in accordance with CAN/ULC S710.2-11 application standard.
- .2 Install two-component foam to locations where indicated, in accordance with CAN/ULC S711.2-11 application standard.

3.7 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.
 - .1 Inspection and testing company shall:
 - .1 Perform inspection for completed work.
 - .2 Perform thickness verification.
- .2 Manufacturer's field review to be in accordance with Section 01 45 00.

3.8 Protection

- .1 Comply with manufacturer's printed recommendations respecting protection.
- .2 Protect polystyrene insulation from extended exposure to sunlight.
- .3 Repair damage resulting from performance of work of this section in manner acceptable to *Consultant*.

END OF SECTION

PART 1– GENERAL

1.1 Summary

- .1 Section includes membrane roofing system as follows:
 - .1 Assemblies shall consist of but not limited to the following components and acceptable installation methods:
 - .1 2-ply SBS modified bituminous membrane:
 - .1 Roofing membrane; Contractor may select from one of the following acceptable application methods:
 - .1 Hot-applied SEBS (base and cap sheets) or asphalt applied base/hot-applied SEBS applied cap sheet.
 - .2 Hot-applied SEBS (base and cap sheets) or asphalt applied base/heat-welded (torch) applied cap sheet.
 - .3 Cold-applied adhesive applied base sheet/heat-welded cap sheet.
 - .4 Heat-welded base sheet/heat-welded cap sheet.
 - .2 Roofing membrane flashings; Contractor may select from one of the following acceptable application methods:
 - .1 Self-adhesive base sheet/heat welded cap sheet.
 - .2 Heat welded base sheet/heat welded cap sheet.
 - .2 Roofing insulation boards and acceptable application methods:
 - .1 INS-51:
 - .1 Use adhesive attachment method (cold-applied adhesive) attachment method where indicated on drawings).
 - .2 Where attachment method is not noted on drawings, *Contractor* may use adhesive method (cold-applied adhesive) or use mechanically fastened application method.
 - .2 INS-52:
 - .1 Use adhesive attachment method (cold-applied adhesive or hot applied asphalt).
 - .3 Insulation cover board:
 - .1 Use adhesive attachment method (cold-applied adhesive or hot applied asphalt).
 - .4 Air and vapour barrier membrane.
 - .5 Parapet sheathing board, mechanically attached to metal framing.
 - .6 Associated roofing accessories and *Products*.

1.2 Administrative Requirements

- .1 Warranty confirmation:

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- .1 ~~Submit with roofing bids~~ a written confirmation letter prepared and signed by roofing membrane manufacturer to affirm that the roofing applicator is approved to obtain specified warranty. [Addendum No.1]
- .2 Coordination:
 - .1 Coordinate with Divisions 21, 22, and 23 to ensure that roof drains are suitable for roofing system design.
 - .2 Coordinate with installers of roof mounted items, equipment, and mechanical and electrical work at roof so that installation will not subvert the integrity of the roofing system.
 - .3 Coordinate with installation of air barrier at walls to ensure complete continuity of air barrier system for building. Roofing air barrier membrane to lap by 75 mm (3") minimum and terminate with wall system air barrier membrane.
- .3 Conduct a pre-installation meeting in accordance with Section 01 31 19.
 - .1 Independent inspection and testing company shall attend the pre-installation meeting.
 - .2 The manufacturer shall meet with the necessary parties at the jobsite to review and discuss project conditions as it relates to the integrity of the roofing assembly.
 - .3 Meet with *Consultant*, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing including installers of roof accessories and roof-mounted equipment.
 - .4 Review methods and procedures related to roofing installation, including manufacturer's written requirements.
 - .5 Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - .6 Examine substrates and existing conditions for compliance with requirements, including flatness and fastening.
 - .7 Review structural loading limitations of roof deck during and after roofing.
 - .8 Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
 - .9 Review governing regulations and requirements for insurance and certificates if applicable.
 - .10 Review temporary protection requirements for roofing system during and after installation.
 - .11 Review roof observation and repair procedures after roofing installation.
 - .12 Forecast weather conditions.

1.3 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 *Product* data sheets: Submit manufacturer's *Product* data sheets for each type of product indicated.

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- .3 Samples:
 - .1 Submit samples complete with manufacturer's labels intact, of materials to be used for work of this section prior to commencement of work. Allowing reasonable time for review and acceptance by *Consultant* and roofing inspection company. Do not proceed with work until samples are accepted.
 - .2 Submit colour samples of roofing cap sheet.
- .4 Roofing manufacturer's warranty sample and wind uplift compliance reports:
 - .1 Manufacturer's pre-installation notification: Submit copy of completed roofing manufacturer's pre-installation notification form at least 10 *Working Days* prior to commencement of roofing installation.
 - .2 Warranty sample: Submit copy of roofing manufacturer's warranty specimen including warranty requirements prior to commencement of roofing installation.
 - .3 Roofing assembly wind uplift compliance reports: Submit roof system assessment reports for applicable CSA A123.21 compliant roof assemblies required to meet requirements for indicated wind uplift pressures and indicated roofing assembly configurations.
- .5 Shop drawings:
 - .1 Include plans, elevations, sections, details, and attachments to other work for the following:
 - .1 Flashing and membrane terminations.
 - .2 Tapered insulation, including slopes, installation diagrams and layouts.
 - .3 Crickets, saddles, and tapered edge strips, including slopes, installation diagrams and layouts.
 - .4 Insulation, substrate board, and parapet sheathing board attachment materials, layouts, and patterns including corners, perimeters, and field of roof locations.
 - .5 Partitioning water cut-off layout.
- .6 Certificates:
 - .1 Installer certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.
 - .2 Manufacturer certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - .1 Submit evidence of compliance with performance requirements.
- .7 LEED submittals:
 - .1 Submit LEED submittals in accordance with Section 01 35 18.
 - .2 Submit documentation to verify compliance with LEED objectives and requirements.

1.4 Closeout Submittals

- .1 Closeout submittals: Submit in accordance with Section 01 78 00.
- .2 Operation and maintenance data: Submit manufacturer's maintenance instructions for incorporation into the operation and maintenance manuals.

1.5 Quality Assurance

- .1 Qualifications:
 - .1 Manufacturers: Company specializing in manufacturing the *Products* specified in this section, with minimum 10 years experience.
 - .2 Installers / applicators / erectors: Provide work of this section, executed by competent installers with minimum 5 years experience in application of *Products*, systems and assemblies specified and with approval and training of *Product* manufacturers.
 - .1 ~~Work of this section shall be installed by a *Subcontractor* that is a member in good standing of the Canadian Roofing Contractors Association (CRCA) and Ontario Industrial Roofing Contractors Association (OIRCA). [Deleted by Addendum No.1].~~
 - .2 Roofing *Subcontractor* must be approved by the membrane manufacturer for the warranty program specified. Submit *Subcontractor's* certification letter prepared by the membrane manufacturer.
- .2 Execute work of this section only under full time supervision of qualified *Subcontractor's* site supervisor.

1.6 Delivery, Storage, and Handling

- .1 Deliver roofing materials to *Project* site in original containers with seals unbroken and labelled with manufacturer's name, product brand name and type, date of manufacture, and directions for storage.
- .2 Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written requirements for handling, storing, and protecting during installation.
- .3 Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck or overloading of structure.
- .4 Handle materials to preclude damage or deterioration. Follow manufacturer's written recommendations.
- .5 Label each container of asphalt bitumen, or provide certificate with each load of bulk bitumen, to attest to flash point (FP), finished blowing temperature (FBT), softening point (SP) and equiviscous temperature (EVT) of bitumen provided for the work.
- .6 Package materials and identify on attached labels the manufacturer, brand, contents, weight as applicable, and *Product* and specification numbers.
- .7 Protect edges of roll goods from damage during handling, and store rolls on end to prevent flattening.

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- .8 Do not store roofing materials on roof. Store them in a dry area protected from inclement weather while roofing installation is not in progress. Store above materials under opaque, breathable and waterproof tarpaulins or in sheds.
- .9 Prevent compression of insulation panels at any point and breakage of edges and corners. Discard wet, cupped, bowed, or otherwise damaged insulation from *Place of the Work*.
- .10 Protect edges and corners of precast concrete paving slabs to prevent damage.

1.7 Field Conditions

- .1 Weather limitations: Proceed with installation only when existing and forecast weather conditions permit roofing system to be installed according to manufacturer's written requirements and warranty requirements.

1.8 Extended Warranty

- .1 Warrant work of this section in accordance with Section 01 78 36.
- .2 Roofing manufacturer shall provide total system warranty including the following:
 - .1 Roofing membrane manufacturer will issue a written document in the *Owner's* name, valid for duration listed below, for the repair of leaks in the roofing membrane to restore the roofing system to dry and watertight condition, to the extent that membrane manufacturing or installation defects caused water infiltration.
 - .2 Warranty shall cover entire cost of the repair(s) required to maintain dry and watertight roofing system during the full warranty duration.
 - .3 Warranty shall include for labour, materials, and installation quality.
 - .4 Warranty shall be non-prorated with no dollar limit (NDL) for duration of warranty.
 - .5 Membrane manufacturer shall review installation of base ply prior to application of cap sheet.
 - .6 20 year warranty duration.

PART 2 - PRODUCTS

2.1 Roofing System Manufacturer

- .1 General: Single source responsibility: each roofing system component to be by one manufacturer.
- .2 Acceptable roof system manufacturers: Subject to compliance with requirements, Provide *Products* by one of the following:
 - .1 Henry Company.
 - .2 IKO.
 - .3 Johns Manville.
 - .4 Siplast.
 - .5 Soprema.
 - .6 Tremco.

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- .3 Substitutions: in accordance with Section 01 25 00.

2.2 LEED Requirements

- .1 Comply with the requirements of Sections 01 35 18, 01 74 19, 01 81 19, and 01 60 13, as applicable.
- .2 Waste management and disposal:
- .1 Comply with the waste management plan developed by the *Contractor* for the *Work* in accordance with Section 01 35 18 and Section 01 74 19. Comply with the directions of the *Contractor's* LEED coordinator with regard to waste management and disposal activities.
- .3 Construction indoor air quality (IAQ) management:
- .1 Comply with the IAQ management plan developed by the *Contractor* for the *Work* in accordance with Section 01 35 18 and Section 01 81 19. Comply with the directions of the *Contractor's* LEED coordinator with regard to IAQ management activities.

2.3 Performance/Design Requirements – Roofing System

- .1 The roofing system shall include roofing system materials required to achieve roofing membrane manufacturer's warranty.
- .2 Roofing system shall resist environmental and wind (uplift) loads, normal movement of structure, and effects of those loads in accordance with the building code and the following:
- .1 Roofing system assemblies shall have been successfully tested by a qualified testing agency to resist project roofing uplift pressures in accordance with the building code.
- .1 CSA A123.21 compliant roof assembly with respect to wind uplift resistance.
- .2 Wind uplift pressures: as indicated on structural drawings.
- .2 Movement within roofing system, and between roofing system and building structure.
- .3 Material compatibility: Provide roofing system materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing system manufacturer based on testing and field experience.
- .4 Roofing system shall prevent water from entering building and roofing assembly through roofing membrane.
- .5 Roof covering classification: Roof assembly shall have a Class C classification as determined in conformance with CAN/ULC S107-10 "Standard Methods of Fire Tests of Roof Coverings".
- .6 Roofing system air barrier shall accommodate substrate movement, construction material changes, and transitions at perimeter conditions without deterioration and air leakage exceeding the following specified limits and requirements:
- .1 Air permeance of air barrier material: Maximum 0.02 L/s m² at 75 Pa (0.004 cfm/ft² at 1.57 psf) to ASTM E2178-13.

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- .2 Rate of air leakage of air barrier system: Maximum 0.15 L/s m² at 75 Pa (0.030 cfm/ft² at 1.57 psf) to ASTM E283-04.
- .3 Water vapour transmission for air / vapour barriers: Maximum 5.7 ng/Pa.m².s. (0.1 perms).
- .4 Pull-off strength of liquid or sheet applied membrane and laps: Cohesive or substrate failure permitted when tested to specified wind load.
- .5 Low temperature flexibility: to -30°C (-22°F) to CGSB 37-GP-56M-1985 or ASTM D5147/D5147M-18.
- .7 Roofing system air barrier shall be joined in an airtight and flexible manner to air barrier material of adjacent building envelope air barrier systems, allowing for relative movement of systems due to thermal and moisture variations and creep. Connection shall be made between the following unless otherwise applicable:
 - .1 Walls and openings.
 - .2 Across construction, control, and expansion joints.
 - .3 Penetrations.

2.4 Roofing System – Roof Membrane and Flashing Sheets

- .1 Roof membrane base sheet and base sheet flashing: SBS-modified asphalt membrane sheet with reinforced elastomeric bitumen:
 - .1 CSA A123.23-15, Type C, Grade 3, composite reinforced.
- .2 Roofing membrane cap sheet and cap sheet flashing: SBS-modified asphalt membrane sheet with reinforced elastomeric bitumen, protected by coloured granules:
 - .1 CSA A123.23-15, Type C, Grade 1, composite reinforced.
- .3 Roofing cap sheet membrane shall be surface covered with granules:
 - .1 Highly reflective granules: Roofing material shall have minimum initial SRI (Solar Reflectance Index) of 78, according to ASTM E1980-11(2019).

2.5 Roofing System - Auxiliary Materials

- .1 General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing system.
- .2 Joint sealant: in accordance with Section 07 92 00.
- .3 Metal flashings: Prefinished sheet metal: in accordance with Section 07 62 00.
- .4 Roof drains: in accordance with plumbing specifications.
- .5 Penetration flashing membrane system:
 - .1 One-component polyurethane/bitumen resin or two-component polymethyl methacrylate-based (PMMA) liquid resin, complete with fleece reinforcing fabric to form reinforced field membrane.
 - .1 Embedded granule finish: Colour and application to match adjacent cap sheet membrane.
- .6 Miscellaneous accessories: Provide miscellaneous accessories recommended by roofing system manufacturer.

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- .7 Flame guard tape: Self-adhesive flame stop membrane composed of glass fleece reinforcement and SBS modified bitumen.

2.6 Roofing System - Fasteners, Adhesives, and Termination Bars

- .1 General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing system.
- .2 Factory-coated steel fasteners and plates complying with corrosion-resistance provisions in FM 4470, designed for fastening roofing components to substrate, tested by manufacturer for required pullout strength and wind uplift resistance, and acceptable to roofing system manufacturer.
- .3 Cold-applied adhesives: in accordance with manufacturer installation requirements.
- .4 Hot-applied asphalt adhesive:
 - .1 Roofing asphalt: CAN/CSA A123.4-04, Type 2 or Type 3 in accordance with manufacturer's installation requirements.
- .5 Hot-applied SEBS (Styrene Ethylbutylene Styrene) adhesive:
 - .1 ASTM D6152/D6152M-12(2018), SEBS modified.
- .6 Termination bars: Pre-punched aluminum bar 25 mm (1") wide x 1.5 mm (1/16") thick x 3048 mm (10 ft) long with 6.4 mm (1/4") x 9.5 mm (3/8") slotted holes on 200 mm (8") centres.

2.7 Roofing System – Parapet Sheathing Board

- .1 Glass-mat faced board: ASTM C1177/C1177M-13, glass-mat, water-resistant gypsum, factory prime coated substrate.
 - .1 Thickness: 16 mm (5/8") thickness.
 - .2 Acceptable *Products*:
 - .1 CGC Securock Brand - Coated Glass-Mat Roof Board'.
 - .1 Water absorption: 10% maximum, ASTM C1177/C1177M-13
 - .2 Georgia Pacific 'DensDeck Prime Roof Board'.
 - .2 Georgia Pacific 'DensDeck Prime Roof Board'.
 - .3 Water absorption: 5% maximum, ASTM C1177/C1177M-13 Substitutions: in accordance with Section 01 25 00.

2.8 Roofing System - Air and Vapour Barrier

- .1 Self-adhering sheet or Factory-Laminated Substrate Board/Air and Vapour Barrier Membrane:
 - .1 Self-adhering sheet: minimum of 0.8 mm (30-mil) thick, polyethylene film laminated to layer of rubberized asphalt adhesive; cold-applied, with slip-resisting surface and release paper backing. Provide primer when recommended by sheet manufacturer.
 - .2 Factory-Laminated Substrate Board/Air and Vapour Barrier Membrane:
 - .1 Description: 15.8 mm (5/8 in) thick board composed of SBS modified bitumen membrane with a polyester reinforcement, factory-laminated on a mineral wool board, top face sanded, side laps part self-adhesive and part thermofusible.

2.9 Roofing System - Insulation

.1 INS-51:

.1 Rigid polyisocyanurate insulation board, inorganic felt faced:

- .1 Description: Closed-cell polyisocyanurate foam core integrally laminated to heavy, durable and dimensionally stable inorganic coated-glass facers, CAN/ULC S704-11 Type 2 and Class 2, HCFC free, 138 kPa (20 psi) minimum compressive strength (at 10% deformation), CAN/ULC-S126-14, CAN/ULC S107-10. LTTR value to CAN/ULC S770-15(R2020).
- .2 Board size: Insulation to be attached using adhesively shall be no larger than 1220 mm x 1220 mm (4 ft x 4 ft).
- .3 Where indicated as tapered:
 - .1 Factory tapered 1:48 (1/4 inch per 12 inches) minimum and as indicated on drawings, and flat board configurations.
 - .2 Provide preformed saddles, crickets, tapered edge strips, sumps, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated, and no less than 1:48 (1/4 inch per 12 inches) in addition to roof structure slope or to tapered insulation slope as applicable.

.2 INS-52:

- .1 Mineral wool board insulation: ASTM C726-12, non-combustible to CAN/ULC-S114-05, rigid mineral wool thermal board dual density insulation. Provide insulation with bitumen layer where required for adhered, mopped, or torched assemblies.
 - .1 Compressive strength; top layer: 139 kPa (20.2 psi) at 10% to ASTM C165-07(2017).
 - .2 Hail performance: FM 4470, Class 1 –SH (Severe Hail), FM 4473, Class 4, UL 2218, Class 4.
 - .3 Basis of design:
 - .1 ModulRTS 'ProtectRSS-X2'.
 - .2 Posi-Slope 'Posi-Rock DD Plus'.
 - .3 Rockwool 'TopRock DD Plus'.
 - .4 Soprema 'Soprarock DD Plus'.
 - .5 Substitutions: in accordance with Section 01 25 00.

2.10 Roofing System - Cover board

- .1 Cover board; multi-ply, semi-rigid asphaltic roofing substrate board: Mineral fortified asphaltic core formed between two asphaltic saturated fibreglass liners, in accordance with roofing membrane manufacturer's requirements for installation and wind uplift resistance performance.
 - .1 Thickness: 4.8 mm (3/16") minimum.
- .2 Factory-Laminated product composed of specified cover board and specified base sheet SBS roofing membrane is acceptable.

2.11 Roofing System - Precast Pavers

- .1 Precast paver slabs: CSA A231.1-19/A231.2-19, 610 mm (24") square x 45 mm (1-3/4") height, slip resistant textured finish, minimum 45 MPa (6526 psi) compressive strength, minimum 4.5 MPa (653 psi) (mean) flexural strength, minimum 4.5% (by mass) water absorption, maximum allowable average loss of mass of not greater than 50 g/m² (0.16 oz/ft²) after 28 cycles.
- .2 Precast support pads: 25 mm (1") thick, extruded expanded polystyrene insulation, to CAN/ULC S701.1-17, Type 4, Class B, self-extinguishing, 35 psi at 5% deflection compressive strength.

2.12 Roofing System - Expansion Joints

- .1 Description:
 - .1 Manufactured from a proprietary copolymer with internal polyester reinforcement, monolithic seam vulcanization.
 - .2 Movement and fabrication: Tri-directional movement capability, joint waterproofing system shall be factory fabricated in one piece for the entire contiguous expansion joint or where length of joint exceeds manufacturer's shipping and handling guidelines shall be lapped and vulcanized by manufacturer's mechanics on site, repair of damaged materials shall be performed by manufacturer's mechanics.
 - .3 Compatible with adhesives and membranes associated with expansion joint construction in accordance with manufacturer's written requirements.
 - .4 Warranted by manufacturer to cover full warranty duration specified in this section.
 - .5 Hydrostatic pressure limit: Working pressure in column of water shall perform under static limit not to exceed 10 m (33 ft).
- .2 Acceptable manufacturers:
 - .1 Situra Inc.
 - .2 Soprema.
 - .3 Substitutions: in accordance with Section 01 25 00.

PART 3 - EXECUTION

3.1 Examination

- .1 Examine substrates, areas, and conditions, with roofing system installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
 - .1 Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
 - .2 Verify that blocking, curbs, and panels are securely anchored to roof deck at penetrations and terminations and that blockings and panels match thicknesses of insulation.
 - .3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Preparation

- .1 Clean substrates of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written requirements. Remove sharp projections where prone to damaging roofing system or reducing roofing performance.
- .2 Prevent materials and debris from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when roofing work is not actively taking place or when rain is forecast.

3.3 Installation - General

- .1 Prepare surfaces and complete waterproofing work in conformance with roofing manufacturer's written requirements.
- .2 Install roofing system elements on clean and dry surfaces, in conformance with manufacturer's requirements.
- .3 Complete roofing system work in a continuous application method as surfaces are readied and weather conditions permit.
- .4 Seal seams that are not covered by a cap sheet membrane in the same day. Do not install cap sheet when moisture is present at/in the base sheet seams.
- .5 Ensure waterproofing conditions for roofs at all times, including protection during installation work by other trades and progressive protection as work is completed (e.g. vents, drains, and other work which penetrates roofing membrane.).
- .6 Lay roofing membrane free from wrinkles, air pockets, fishmouths, tears, and prominent lap joints. Full bond cap sheet to base sheet. Seams shall be lapped and fully bonded.
- .7 Prior to installation of base sheet and cap sheet, allow sheet to relax after unrolling. Relax time to be as recommended by manufacturer based on concurrent ambient temperature.
- .8 Extend roofing to outer edges of roof and up vertical surfaces at least 200 mm (8") above horizontal roofing, and full height beneath counter flashing and top of curb flashing.
- .9 Complete roofing up to line of termination for each day's work.
- .10 Roofing systems where hot-applied adhesives are used to adhere field base sheet, insulation, and / or sheathing board with oxidized asphalt:
 - .1 Mechanical attachments (screws and plates) shall be affixed, at 305 mm (12") centres, at the base of the upstand.
- .11 Roofing systems adhered with cold adhesive or hot-applied adhesive, and where insulation at bottom of vertical upstand is greater than 150 mm (6") in thickness:
 - .1 Install continuous fastening bar and anchors at bottom of vertical upstand (screws and plates with length greater than 150 mm (6") are not permitted).

3.4 Cover board

- .1 Cover board shall be fully adhered to insulation substrate.
- .2 Lay out cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows.
- .3 Offset cover board with joints of insulation a minimum of 300 mm (12") in each direction.

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- .4 Loosely butt cover boards together.

3.5 Application of Primer

- .1 Roofing substrates surfaces shall receive a coat of primer at a rate required by roofing manufacturer's written requirements.
- .2 Surfaces to be primed must be free of rust, dust or any residue that may hinder adherence.
- .3 Cover primed surfaces with roofing membrane as soon as possible (same day coverage for self-adhesive membranes).

3.6 Air and Vapour Barrier

- .1 Self-adhering sheet: Prime substrate if required by manufacturer. Install self-adhering sheet over area to receive sheet, side and end lapping each sheet in accordance with manufacturer's written requirements. Roller seal laps.
- .2 Completely seal air and vapour barrier at terminations, obstructions, and penetrations to prevent air movement into roofing or into adjacent assemblies.

3.7 Asphalt Application

- .1 Asphalt Heating: Heat roofing asphalt and apply within plus or minus 14°C (25°F) of equiviscous temperature unless otherwise required by roofing system manufacturer. Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating. Do not heat roofing asphalt within 14°C (25°F) of flash point. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than 4 hours.
- .2 Apply asphalt at EVT and do not spread more than 1830 mm (6 ft) of hot asphalt in front of each roll and reduce distance accordingly during cold weather. Ensure hot asphalt in kettle is in constant use and circulation to avoid distillation.
- .3 Apply asphalt at minimum rate of 1.2 kg/m² (25 lb/100 ft²).

3.8 Insulation Application

- .1 Install in accordance with roofing membrane and insulation manufacturer's written requirements.
- .2 Install insulation with mechanical or adhesive attachment methods.
 - .1 Use adhesive attachment at roofing assemblies where indicated on drawings (where mechanical fasteners are not acceptable).
 - .2 Mechanically fastened insulation attachment: Fasteners shall be attached to steel deck's upper flutes and at spacing to meet performance requirements.
- .3 Stagger and offset vertical joints from preceding insulation boards, 305 mm (12").
- .4 Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- .5 Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.

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- .6 Install only as much insulation as can be covered with membrane roofing at the end of the workday.
- .7 Install insulation boards with edges in moderate contact without forcing and fill gaps greater than 6 mm (1/4") with insulation.
- .8 Cut insulation to fit to blocking, upstands, and penetrations through roof; fill gaps greater than 6 mm (1/4") with insulation.
- .9 Install tapered insulation under area of roofing to conform to slopes indicated.
 - .1 Apply insulation adhesive to underside and immediately bond tapered insulation to substrate.
- .10 Protect and keep insulation dry (in new condition). Do not install insulation which is not in dry condition.

3.9 Partitioning Water Cut-Offs – Conventional Roofing System

- .1 Partitioning water cut-offs: Provide partitioning water cut-offs by installing strip of air / vapour barrier membrane to seal sections of roofing to smaller sections, and at the exposed edges of insulation under at roof edges and vertical surfaces. Install partitioning water cut-offs between base sheet and air / vapour barrier to provide watertight separation to adjacent roofing section.
- .2 Locate water cut-offs at 930 m² (10,000 SF) maximum sections.

3.10 Installation of Roofing Membrane and Roofing Membrane Flashings

- .1 Tape substrate joints in substrate to prevent the passage of flame using flame guard tape.
- .2 Install membrane in accordance with manufacturer's requirements.
- .3 Install roofing membrane free wrinkles, air pockets or fishmouths. Provide homogenous seam.
- .4 Cut off corners at end laps to be covered by the next roll.
- .5 Install a reinforcing gusset in inside and outside corners.
- .6 Seal overlaps at the end of the workday.
- .7 After installation of cap sheet, check lap seams on cap sheet for watertight seal.

3.11 Waterproof Expansion Joint Installation

- .1 Install components of the system in accordance with the manufacturer's written requirements.
- .2 Expansion joint system shall to be wholly encapsulated between the plies of the modified bitumen membrane and be watertight.

3.12 Roofing Details

- .1 Install as indicated on drawings and with various roofing details illustrated in roofing manufacturer's written requirements.

3.13 Roof Drains

- .1 Ensure that roof drains are set to permit drainage, located at lowest possible location, and properly secured.
 - .1 Cut and slope insulation at each drain to form a sump and to accommodate flashing immediately surrounding drain.
 - .2 Review roof drain locations with *Consultant* prior to installation of drains.
- .2 Drain sumps:
 - .1 Install tapered insulation.
 - .2 Apply penetration flashing membrane to drain sump area, complete with fleece reinforcing fabric to form reinforced field membrane. Install to penetration flashing membrane to 300 mm (12") beyond drain sump and to within drain assembly to edge of roofing membrane.
 - .3 Embed coloured granules to match installation to granulated roofing cap sheet.
- .3 Temporarily block drain pipes during application of membrane. Remove blocking when work is not in progress and after work of this section is completed.
- .4 Carry membrane, penetration flashing membrane, and insulation to edge of drain base and trim around drain opening, and seal to drain in accordance with manufacturer's written requirements.
- .5 Install membrane to drain in accordance with manufacturer's written requirements to provide watertight seal.
- .6 Fill void between drain body and roof insulation board/base structure support with two-component polyurethane foam insulation.

3.14 Roof Penetrations

- .1 Install curb flashings around ducts, pipes, structural steel, and other projections through membrane systems in conformance with manufacturer's written requirements and as detailed.
- .2 Install penetration flashing supplied under work of mechanical and under the work of this section, in accordance with roofing manufacturer's written requirements.
- .3 Prime metal flanges with primer and allow solvents to flash off prior to installation.
- .4 Remove poly film on areas to receive metal flashing. Set metal flange in full layer of waterproofing mastic to provide positive bond and seal.
- .5 Install base ply to the base of the metal flashing staying short of curved metal section.
- .6 Install cap ply to the base ply flashing ensuring a full bond to the base ply and apply bead of waterproofing sealer at the termination point.
- .7 Install penetration flashing membrane and fleece in accordance with manufacturer's requirements.

3.15 Metal Flashings

- .1 Install metal flashings in accordance with Section 07 62 00.

3.16 Paver Installation

- .1 Install pavers in accordance with paver manufacturer's written requirements. Align the top cap joint spacers with paver edges. Level pavers in succeeding rows.
- .2 Install pavers on support pads cut to be 50 mm (2") less than overall paver dimensions.
- .3 Shim or adjust to level and as necessary to prevent rocking of pavers.
- .4 Installation tolerances:
 - .1 Step in face alignment between paver faces: Plus or minus 1.5 mm (1/16").
 - .2 Jog in joint alignment between paver sections: Maximum 1.5 mm (1/16").
- .5 Do not use pavers with chips, cracks, voids, stains, or other defects which might be exposed to view in the finished work.
- .6 Machine cut pavers as necessary to fit the conditions indicated. Joints shall be no wider than the typical paver to paver joint.

3.17 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00 and as follows:
 - .1 Inspection and testing:
 - .1 Prior to installation of cap sheet membrane, base sheet membrane installation shall be reviewed by manufacturer and inspection and testing company, who shall each submit field review reports to the *Consultant*.
 - .2 Independent inspection and testing company shall perform:
 - .1 Inspections and provide inspection reports.
 - .2 Tests and provide test reports:
 - .1 Core cuts (if requested).
 - .3 Moisture survey:
 - .1 Submit results of a non-destructive moisture test of roof system completed by approved third party. Utilizing one of the following methods:
 - .1 Infrared thermography.
 - .2 Nuclear backscatter.
 - .3 Electric field vector map testing.
 - .2 If test results or inspections show roofing does not comply with requirements, remove and replace or repair the roofing as recommended in writing by manufacturer, and make further repairs after retesting and inspecting until roofing installation passes.
 - .2 Manufacturer's field review to be in accordance with Section 01 45 00.

3.18 Adjusting and Cleaning

- .1 Remove applicator's equipment and debris as work progresses, and at completion of the work of this section in accordance with Sections 01 78 00 and 01 74 19.
- .2 Remove markings from finished surfaces.

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- .3 Repair or replace defaced or disfigured finishes caused as a result of the work of this section.

END OF SECTION

Metal Flashing

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PART 1 - GENERAL

1.1 Summary

- .1 Section includes:
 - .1 Supply and installation of prefinished metal (steel) flashings.
 - .2 Supply and installation of prefinished metal (aluminum) flashings.
- .2 Conduct a pre-installation meeting in accordance with Section 01 31 19.
 - .1 Independent inspection and testing company shall attend the pre-installation meeting.

1.2 Submittals

- .1 Submit required submittals in accordance with Section 01 33 00.
- .2 Shop drawings:
 - .1 Submit shop drawings including the following:
 - .1 Plans, elevations, sections, and attachment details.
 - .2 Detail fabrication and installation layouts, expansion-joint locations, and key details. Distinguish between shop and field assembled work.
 - .3 Include identification of material, thickness, weight, and finish for each item and location in the work.
 - .4 Include details for forming, including profiles, shapes, seams, and dimensions.
 - .5 Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
 - .6 Include details of termination points and assemblies.
 - .7 Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contracting from fixed points.
 - .8 Include details of roof penetrations flashing.
 - .9 Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counter flashings as applicable.
 - .10 Include details of special conditions.
 - .11 Include details of connections to adjoining work.
- .3 Samples:
 - .1 Submit full-size samples of each specified flashing material formed to detailed profile including corner, curb, cap, and parapet flashing, and coping including lock-joints and hold-down clips.
 - .2 Submit 2 - 50 mm x 50 mm (2" x 2") samples of each type of sheet metal material, colour and finish.
- .4 LEED submittals:

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- .1 Submit LEED submittals in accordance with Section 01 35 18.
- .2 Submit documentation to verify compliance with LEED objectives and requirements.

1.3 Quality Assurance

- .1 Qualifications:
 - .1 Installers / applicators / erectors: Provide work of this section, executed by competent installers with minimum 5 years experience in application of *Products*, systems and assemblies specified and with approval of *Product* manufacturers.
 - ~~.1 Work of this section shall be installed by a *Subcontractor* that is a member in good standing of the Canadian Roofing Contractors Association (CRCA), who has been a member for at least 5 years. [Deleted by Addendum No.1]~~
 - .2 Sealant shall be applied by a *Subcontractor* of recognized standing, having preferably not less than 5 years of proven experience in this type of work, and who has the necessary equipment and skilled mechanics to carry out the work of this section satisfactorily and can substantiate this to satisfaction of *Consultant*.
 - .2 Quality standards:
 - .1 Quality of fabrication and installation of sheet metal work shall comply with recommendations published by Sheet Metal and Air Conditioning Contractors National Association.
 - .3 Mock-ups:
 - .1 provide on-site mock-up of the following:
 - .1 Coping flashing.
 - .2 Roof edge flashing.
 - .3 Counter flashing.
 - .4 Fascia flashing.
 - .5 Special flashing conditions.
 - .2 Include outside and inside corner condition with mitred joints, methods of joinery to prevent moisture infiltration, expansion and contraction.

1.4 Delivery, Storage, and Handling

- .1 Keep materials and equipment free from debris, ice, snow and contaminants. Allow air to circulate around metal components, sheets and break shapes.
- .2 Protect holes, and reglets from water and ice during freezing weather.

PART 2 - PRODUCTS

2.1 LEED Requirements

- .1 Comply with the requirements of Sections 01 35 18, 01 74 19, 01 81 19, and 01 60 13, as applicable.
- .2 Waste management and disposal:

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- .1 Comply with the waste management plan developed by the *Contractor* for the *Work* in accordance with Section 01 35 18 and Section 01 74 19. Comply with the directions of the *Contractor's* LEED coordinator with regard to waste management and disposal activities.

- .3 Construction indoor air quality (IAQ) management:

- .1 Comply with the IAQ management plan developed by the *Contractor* for the *Work* in accordance with Section 01 35 18 and Section 01 81 19. Comply with the directions of the *Contractor's* LEED coordinator with regard to IAQ management activities.

2.2 Prefinished Steel Flashing

- .1 Sheet steel: Commercial quality to ASTM A653/A653M-13 with Z275 designation zinc coating.
 - .1 Minimum thickness:
 - .1 0.61 mm (0.0239") (24 gauge).

2.3 Prefinished Aluminum Flashing

- .1 Aluminum flat sheet: Flat aluminum sheet to ASTM B209/B209M-21a, to the following minimum thickness and alloy:
 - .1 Painting quality: 3003H14 or 3105H14 to ANSI H35.1/H35.1M-2017.
 - .2 Minimum thicknesses:
 - .1 Except at exterior bases: 2 mm (0.0787").
 - .2 At exterior base details: 3.17 mm (0.125")

2.4 Prefinished Metal Finishes

- .1 Provide the following finish to exposed prefinished steel:
 - .1 Finish: Silicone polyester, with ceramic pigments and other select inorganic pigments, 2-coat system.
 - .1 Coating shall not crack, chip, or peel (lose adhesion) for twenty-five (25) years from date of application. This does not include minute fracturing that may occur during the normal fabrication process. Coating shall not chalk in excess of a number eight (No. 8) rating, in accordance with ASTM D4214-07(2015) method D659 at any time for twenty (20) years from date of application; will not change colour more than five (5) Hunter ΔE units as determined by ASTM D2244-22.
 - .2 Colour to later selection by *Consultant* from manufacturer's full range.
 - .3 Acceptable *Products*:
 - .1 ArcelorMittal Dofasco 'Perspectra Series'.
 - .2 Baycoat 'Perspectra Plus Series'.
 - .3 Firestone Metal Products (SMP or Kynar).
 - .4 Valspar 'WeatherXL'.
- .2 Provide the following finish to exposed prefinished aluminum:

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- .1 Exposed aluminum surfaces: 70% Kynar 500 or Hylar 5000 fluoropolymer resin systems, ceramic pigments and other select inorganic pigments to AAMA 2605-22.
 - .1 Colour: to later selection by *Consultant* from manufacturer's full range.
 - .2 Basis of design:
 - .1 PPG 'Duranar XL'.
 - .2 Substitutions: in accordance with Section 01 25 00.

2.5 Accessories

- .1 Isolation coating: to CAN/CGSB-1.108, bituminous type.
- .2 Sealants: in accordance with Section 07 92 00, colour as selected by *Consultant* from manufacturer's full range.
- .3 Cleats: of matching metal to flashing material, continuous, and of greater thickness than flashing material. Joints in cleats shall not coincide with joints in perimeter edge metal. Allow a 12.7 mm (1/2") gap between pieces.
- .4 Fasteners:
 - .1 Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal.
 - .2 General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head:
 - .1 Exposed screws: 38 mm (1-1/2") long minimum at 450 mm (18") on centre maximum. Heads matching colour of sheet metal using plastic caps or factory-applied coating. provide metal-backed EPDM washer under heads of exposed fasteners.
 - .2 Blind fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
 - .3 Cleat fasteners: Corrosion-resistant barbed angular ring or screw shank nail; length to achieve approximately 32 mm (1-1/4") penetration into nailer; fasten at 150 mm (6") on centre.
 - .3 Fasteners for prefinished aluminum sheet: Series 300 stainless steel.
 - .4 Fasteners for prefinished galvanized steel sheet: Series 300 stainless steel.
 - .5 Fasteners and plates to meet the requirements of FM 4470-12 for wind uplift and corrosion resistance.
- .5 Flexible flashing membrane; high temperature grade for use at locations where membrane is not protected by insulation:
 - .1 Description:
 - .1 Thickness: 0.76 mm (30 mils) minimum.
 - .2 Self-adhesive grade rubberized membrane backed by high density polyethylene.
 - .3 Primer for substrate.

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- .4 High temperature grade to resist softening at 105°C minimum.
- .2 Acceptable *Products*:
 - .1 Bakor 'Blueskin PE 200 HT'.
 - .2 Firestone 'Clad-Gard SA'.
 - .3 Grace 'Ultra'.
 - .4 Soprema 'LASTOBOND SHIELD HT'.
- .6 Flexible flashing membrane; standard temperature grade for use at locations where membrane is protected by material with insulating properties:
 - .1 Description:
 - .1 Thickness: 1 mm (40 mils) minimum.
 - .2 Self-adhesive grade rubberized membrane backed by high density polyethylene.
 - .3 Primer for substrate.
 - .2 Acceptable *Products*:
 - .1 Bakor 'Blueskin Roof RF200'.
 - .2 Grace 'Ice & Water Shield'.
 - .3 Soprema 'LASTOBOND SHIELD'.

2.6 Fabrication

- .1 Fabricate metal flashings and other sheet metal work in accordance with applicable SMACNA "Architectural Sheet Metal Manual (Seventh Edition) details and as indicated.
- .2 Form pieces in 3048 mm (10') maximum lengths. Make allowance for expansion at joints.
- .3 Sealed joints: Form non-expansion but movable joints in metal to accommodate sealant.
- .4 Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" and by FMG Loss Prevention Data Sheet 1-49 for application, and of greater thickness of metal being secured.
- .5 Hem exposed edges on underside 12.7 mm (1/2"). Mitre and seal corners with sealant.
- .6 At parapets, provide 25.4 mm (1") minimum overlap between bottom of wood blocking or flashing anchorage support and edge of drip or termination of flashing.
- .7 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- .8 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.
- .9 provide 25.4 mm (1") gap between drip edges and wall finish material to redirect water runoff away from walls.
- .10 provide 25.4 mm (1") minimum overlap between bottom of wood blocking or flashing anchorage support and edge of drip or termination of flashing.
- .11 Shop fabricate inside and outside corners.

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PART 3 - EXECUTION

3.1 Flexible Flashing Underlayment Installation

- .1 Apply primer to concrete masonry and precast concrete substrates.
- .2 Install in a consecutive weatherboard method starting at bottom or base of wall and working up.
- .3 provide minimum of 50 mm (2") side laps and 75 mm (3") end laps.
- .4 Cut to manageable lengths, position membrane for alignment, remove protective poly-film and firmly apply pressure to assure adhesion.
- .5 Eliminate wrinkles or gaps, roll entire membrane surface (including seams) with a counter top or "J-roller" to ensure full contact and adhesion.
- .6 Seal membrane terminations, heads of mechanical fasteners, masonry tie fasteners, around penetrations, duct work, electrical and other apparatus extending through the air barrier membrane and around the perimeter edge of membrane terminations.
- .7 Flashing membrane shall be applied in weatherboard fashion starting at bottom of base of wall and working up, in and around the full perimeter of openings, to provide water tight protection and according to the following procedures:
 - .1 Apply the first strip horizontally immediately below the sill, cut it sufficiently long to extend past each side of the window, so that it projects even with the vertical jamb flashing to be applied later. Turn sill flashing up 50 mm (2") at ends of sill.
 - .2 Sill flashing shall overlap wall membrane. Overlap jamb at head flashing membrane in the same manner.

3.2 Roof Flashing Installation

- .1 Install sheet metal work in accordance with SMACNA Architectural Sheet Metal Manual - Seventh Edition - 2012.
- .2 Provide watertight flashing installing capable of resisting specified uplift pressures in accordance with roofing specifications, thermally induced movement and exposure to weather.
- .3 Provide minimum 10% slope for drainage towards roof at parapet locations, with minimum 2% sloped to drain at remaining flashing locations.
- .4 provide continuous cleats for attachment of flashings at exterior face of wall and cleats for interior face of wall.
- .5 provide radius (3-piece) copings for curved wall condition unless otherwise indicated.
- .6 Prefabricate corner copings in 610 mm (24") x 610 mm (24") sections.
- .7 Concealed fastenings and cleats, from view except where exposed flashings are accepted by *Consultant* prior to installation.
- .8 Flash joints using S-lock forming tight fit over hook strips/cleats; unless otherwise indicated.
- .9 Install surface mounted flared joint true and level, and caulk top of reglet with sealant at reglets.
- .10 Insert metal flashings to other materials and flashings to form weather-tight junction.

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- .11 Provide prefinished metal flashing over equipment curbs which are covered with roofing membrane.
- .12 Turn top edge of flashing into recessed reglet or mortar joint where indicated, to minimum depth of 25 mm (1"). Wedge flashing securely into joint. Seal flashing at reglet and cap flashing with sealant.
- .13 Expansion provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 3048 mm (10 ft) and provide uniform joint spacing with no joints allowed within 610 mm (24") of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 25.4 mm (1") deep, filled with sealant concealed within joints.
- .14 Install flexible flashing membrane in accordance with manufacturer's printed installation instructions.

3.3 Wall Flashing Installation

- .1 General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- .2 Ensure that sill flashing extends past cladding complete with drip edge. At concrete openings, ensure that sill flashing project out past concrete openings.
- .3 Through-wall flashing: Installation of through-wall flashing is specified in Division 4.
- .4 Reglets: Installation of reglets is specified in Division 3 under "Cast-in-Place Concrete".

3.4 Installation of Roof Accessories

- .1 Incorporate devices to which roofing and flashing may be secured.
- .2 Install work to ensure that roofing and flashings will be properly applied to maintain building envelope weather-tight.

3.5 Installation Tolerances

- .1 Shim and align sheet metal flashing and trim within installed tolerance of 6 mm in 6 m (1/4 inch in 20 feet) on slope and location lines as indicated and within 3.2 mm (1/8") offset of adjoining faces and of alignment of matching profiles.

3.6 Field Quality Control

- .1 Conduct quality control in accordance with Section 01 45 00.
 - .1 Independent inspection and testing company shall perform inspection of completed work.
 - .2 The work of this section will be inspected and tested in conjunction with inspection and testing of roofing work.

3.7 Adjusting and Cleaning

- .1 Remove deposits, stains or protections and wash metals left unpainted and exposed to view as recommended by manufacturer of metal or paint finish.

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3.8 Protection

- .1 Advise *Contractor* of required procedures for surveillance and protection of flashings and sheet metal work during construction to ensure that work will be without damage or deterioration other than natural weathering.

END OF SECTION

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 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.

1.3 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.

1.4 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.

1.5 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.

1.6 SUBMITTALS

- .1 LEED Submittal:
 - .1 Submit require submittals in accordance with Section 01 74 19.
 - .2 Submit documentation to verify compliance with LEED objectives and requirements.
- .2 Submit opening information, shop drawings for reinforcement, and certificates for review by the Consultant.
 - .1 Refer to Section 01 33 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 New structure:
 - .1 Review typical details on structural drawings with respect to openings in walls, slabs, openings at tiebacks, sleeve and conduit placement in concrete structures.
 - .2 For slabs and vertical sleeves through beams, dimension openings, recesses and sleeves, and relate to suitable grid lines.
 - .3 For horizontal sleeves through beams, provide elevation with sleeve location, dimensioned to grid lines, or nearest support, and top of beam.
- .3 Existing structure:
 - .1 Where openings are to be cut into existing structure, submit record x-rays or other approved positive records, indicating all cast-in materials including reinforcing steel, post-tensioning wires, conduits etc., related to grid lines and elevation datum along with proposed cutting location.
- .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 Shop Drawings for Mechanical Splices
 - .1 Submit installation drawings showing, amongst other items, location, elevation and size of splices, materials and procedures.
- .7 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.
- .8 Substitutions
 - .1 Substitution of different size bars permitted only upon written approval of Consultant.
 - .9 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 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.

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 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.

3.6 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.

PART 4- ADDITIONAL REQUIREMENTS FOR ARCHITECTURAL CONCRETE

4.1 AEC 1 - Basic Elements

- .1 Strictly maintain bar clearances for architectural concrete. Place spacers regularly and squarely against forms. Spacers shall not be used between reinforcement and an exposed vertical concrete face.
- .2 The location of spacers shall not cause constriction adjacent to other inserts which may impede the placing of concrete. The cover to reinforcement shall be taken from the deepest penetration of arrises or reglets.
- .3 Use spacers and support accessories so that no metal comes closer than 40 mm to an exposed surface.
- .4 Ensure that no tie wires project within 40 mm of an exposed face.

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- .5 Take particular care not to damage form sheathing surfaces during installation of reinforcement.
 - .6 Support Accessories for Architectural Concrete
 - .1 An approved precast concrete, plastic or other non-corroding type of chair, bolster or spacer of sufficient strength to rigidly support the weight of reinforcement and construction loads. Tie wires shall be non-corrosive to sample approved by Consultant.

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 00.
 - .6 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 LEED REQUIREMENTS

- .1 Comply with the requirements of Section 01 35 18.
- .2 Requirements in Section 01 74 19 pertinent to the work of this section include, but are not limited to, the following:
 - .1 Waste management and disposal: Comply with the waste management plan developed by the Contractor for the work in accordance with Section 01 35 18. Comply with the directions of the Contractor's LEED coordinator with regard to waste management and disposal activities.

- .2 Construction indoor air quality (IAQ) management: Comply with the IAQ plan developed by the Contractor for the work in accordance with Section 01 35 18. Comply with the directions of the Contractor's LEED coordinator with regard to construction indoor air quality.
- .3 Low-emitting materials: All adhesives, sealants, primers, paints and coatings shall have a VOC content that is less than the content limits defined in Section 01 35 18.
- .4 Regional materials: A minimum of 100% of the materials used in the work of this section shall meet regional material requirements.
- .5 Recycled content: Recycled content requirements are applicable to the following when used in the work of this section:
 - .1 *Reinforcing Steel: 90% recycled content minimum*

1.4 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.

1.5 TOLERANCES

- .1 Perform placing operations so that completed work will be within the tolerances set out in CAN/CSA-A23.1 and as listed below:
 - .1 Variations in building lines which result in extension of the building over lot lines or restriction lines will not be permitted.
- .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.
- .3 Note the need for accurate alignment of perimeter slab edges both horizontally and vertically.

1.6 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 and Air Content: As called for on the Drawings. These requirements are for concrete at the point of placing.
- .5 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.
- .6 Use of calcium chloride is not permitted.
- .7 DCI Corrosion inhibiting admixture. Refer to drawings for scope.
- .8 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.

1.7 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.*

1.8 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 LEED Submittal:
 - .1 Submit required submittals in accordance with Section 01 35 18.
 - .2 Submit documentation to verify compliance with LEED objectives and requirements.
 - .3 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.

1.9 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 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 to 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 DCI Corrosion Inhibiting Admixture, as supplied by W.R. Grace & Co. Dosage in accordance with manufacturer's recommendations, but at least 10 litres per cubic metre.
 - .2 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.
- .15 Crystalline Waterproofing Admixture:
 - .1 In accordance with 03 15 20.
 - .2 AQUAFIN-IC integral concrete admixture.
- .16 Bonding agent: Sikadur 32 Hi-Mod epoxy-based protective coating and bonding adhesive, as supplied by Sika Canada, or approved equivalent.
- .17 Non-shrink grout: minimum 30 MPa grout, as supplied by CPD Construction Products, or approved equivalent.

PART 3 – EXECUTION

3.1 FOOTINGS

- .1 Refer to drawings for soil criteria for bearing of footings.
- .2 Founding elevations are noted, 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 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.
- .6 Keep a record of footing founding elevations.
- .7 Construct footings in a particular area commencing from the lowest footing elevation and proceeding to the higher elevation.
- .8 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.
- .9 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.
- .10 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.

- .11 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.
- .12 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.
- .13 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.
- .14 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.
- .15 Waterstops:
 - .1 Refer to detailed requirements below.

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 WATERSTOPS

- .1 Setting waterstops: In order to eliminate faulty installation that may result in joint leakage, take care in the correct positioning of the waterstops during placing of concrete. Support the waterstops during the progress of the work to ensure the proper embedment in the concrete. Equally divide the symmetrical halves of the waterstops between the concrete pours at the joints. The centre axis of the waterstops shall coincide with the joint openings at the plane of installation of the waterstop. Ensure maximum density and imperviousness of the concrete by thoroughly working it in the vicinity of all joints.
- .2 Placement of concrete around waterstops: Take care in placing concrete around waterstops by careful working, routing, and vibrating to ensure that all air and rock pockets have been eliminated.
- .3 Use butted, welded connections in accordance with manufacturer's recommendation. Only straight heat sealed welds shall be performed in the field. Use preformed or shop welded corners and intersections.

3.4 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 Where concrete members are case on or against precast concrete panels, protect the panels from staining with a plastic membrane protective cover.
- .9 Co-ordinate with general contractor placement procedures to ensure the humidity levels in concrete meet warranty requirements of the finishes at time of installation.

3.5 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, Clause 7.4.

.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.

3.6 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.

3.7 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.

3.8 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.

3.9 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.

3.10 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.

3.11 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.

PART 4 – ADDITIONAL REQUIREMENTS FOR ARCHITECTURAL CONCRETE

4.1 AEC 1 - Basic Elements

- .1 Quality of Finish:
 - .1 The quality of finish shall be such that when the forms are stripped, it meets the standards set out below, without further finishing work other than treatment of tie holes, sandblasting, and clean-up, except in the case of smooth concrete for paint, grinding of joints and filling of voids will be permitted.
 - .2 Dense, even concrete free of major defects such as deep or extreme honeycombing, inconsistencies in plane, severe cold joint lines and major loss of fines. Minor imperfections may be acceptable. Major defects will necessitate replacement. The judgement as to what constitutes major or minor defects will be the Consultant's. Patching will not be permitted and if used, will constitute a major defect. Repairs, i.e. removal of sections of a member, may be carried out if approved by the Consultant, but the repair shall match the colour and texture of the surrounding concrete.
 - .3 Concrete members of generally uniform colour.

Cast-in-Place Concrete

- .4 Concrete members with sharp, accurate definition at corners, arrises, reglets and the like, generally free of chipped or spalled areas and within dimensional tolerances set out in ACI 347R/CAN/CSA-S269.3. Members shall be visually straight.
 - .5 Plane surfaces without protuberances, indentations, ridges or bulges.
 - .6 Sandblasted surfaces with the required uniform depth of cut-back, distribution of aggregate and with colour and texture matching the sample panel designated by the consultant.
 - .7 Under no circumstances shall repair to any architectural concrete be undertaken without the consultant's consent will be classified as defective Work and the consultant may require their removal and replacement.
- .2 Placing of Concrete.
- .1 Before concrete is placed, thoroughly clean forms, re-tighten as is necessary and saturate the surface of construction joints and form sides with water.
 - .2 In walls or columns, except where these are to be sandblasted, begin the pour by depositing in the bottom of the form a 75 mm layer of cement sand mortar of the same mix as the concrete used for the work, except that the coarse aggregate is omitted. Pour concrete immediately after the grout is poured.
 - .3 The maximum free drop of concrete shall not exceed 1.2 m.
 - .4 Deposit concrete in as close to its final position as possible and do not allow to flow laterally more than 600 mm.
 - .5 For depositing concrete in walls provide suitably sized tapered pouring boxed to funnel the concrete into the forms. Provide sufficient boxes for each pour such that they can be placed simultaneously at approximately 2 m on centres for the entire length of the pour.
 - .6 To compact concrete use internal vibrators 25 mm to 50 mm in diameter as required. Apply vibrators at sufficiently short intervals (about 500 mm to 1000 mm) of distance, that vibrated areas overlap without omission of any part. Ensure that the vibrators are inserted through the layer being compacted but take care not to damage form sheathing. Leave vibrator in place from 5 to 15 seconds and withdraw slowly leaving the vibrator operating.
 - .7 Arrange operations so that once a pour is started, concreting is carried on continuously and the concrete at the surface of the pour is maintained plastic until the completion of section.
 - .8 Shortly after concrete is placed and compacted to the top of walls or columns or to the top of construction joints, rework the concrete with wooden chisels at the exposed faces to a depth of at least 2' .6 m and then re-vibrate.
 - .9 At the correct time provide a fine wood float surface to tops of walls, balustrades, retaining walls and the like. Remove laitance as necessary before finishing the concrete. After stripping, lightly rub corners with an emery stone to eliminate sharp edges.
 - .10 Trowel the surface of construction joints adjacent to exposed faces, flush and level. Joints in walls shall be made at the top of any reglet unless shown otherwise.
- .3 Treatment of Formed Surfaces
- .1 In addition to the above requirements, go over the surface, remove ties, nails, timber, inserts, minor imperfections, leaving the surface clean.

- .2 Where major defects are revealed, repair as the Consultant directs.
 - .3 Where in the Consultant's opinion defects are minor, repair as follows or as the Consultant may otherwise direct. Cut out affected areas, saturate cut out areas, voids, pit holes and form tie holes with water and fill with a cement mortar containing an approved type of latex bonding agent. Mortar mix and application shall be in accordance with the recommendations of the manufacturers of the bonding agent.
 - .4 After the mortar stiffens, wipe the whole surface clean such that no material remains on the surface, except that within the voids and such that finished surface is clean and smooth. Cure the patched areas by keeping moist for at least 7 days.
 - .5 Where directed by the Consultant, power stone concrete surfaces to remove surface imperfections remaining after the treatment noted above has been carried out.
 - .6 After forms are stripped go over the surface carefully, removing loose concrete, lumber in reglets, minor fins and the like, leaving the surfaces clean. After the surfaces are cleaned the consultant will make an examination of them to determine their acceptability. If unacceptable, the Contractor shall remove the members and replace them at no extra cost to the Owner.
 - .7 Patching will only be permitted where it is required to an insignificant extent. If the consultant permits patching, demonstrate to the Consultant's satisfaction that the patch will accurately match the colour and texture of the surrounding concrete and will have satisfactory tenacity.
- .4 Protection.
- .1 At all times during the work protect architectural members as required with polyethylene sheets or the like from staining or becoming coated with leakage, due to continuing concreting operations. Protect concrete from staining due to rusting of reinforcing steel.

END OF SECTION 03 30 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 Paint and steel preparation for paint systems: Section 09 91 00
 - .5 Paint Systems and Anti-Corrosion Schedule: Section 09 91 01
 - .6 Paint and steel preparation for high performance paint systems: Section 09 96 00
- .4 Work Furnished but not Installed:
 - .1 Anchor bolts, bearing assemblies and other structural steel connections to be cast into concrete.
 - .2 Shelf angles and related connections to be built into concrete to receive masonry.
 - .3 Bearing plates and related connections for metal deck to be built into masonry or concrete.
 - .4 Loose lintels, shelf angles and plates to be built into masonry.

1.2 LEED REQUIREMENTS

- .1 Comply with the requirements of Section 01 35 18.
- .2 Requirements in Section 01 35 18 pertinent to the work of this section include, but are not limited to, the following:
 - .1 Waste management and disposal: Comply with the waste management plan developed by the Contractor for the work in accordance with Section 01 74 19. Comply with the directions of the Contractor's LEED coordinator with regard to waste management and disposal activities.
 - .2 Construction indoor air quality (IAQ) management: Comply with the IAQ plan developed by the Contractor for the work in accordance with Section 01 35 18. Comply with the directions of the Contractor's LEED coordinator with regard to construction indoor air quality.
 - .3 Low-emitting materials: All adhesives, sealants, primers, paints and coatings shall have a VOC content that is less than the content limits defined in Section 01 35 18.
 - .4 Regional materials: A minimum of 20% of the materials used in the work of this section shall meet regional materials requirements.

- .5 Recycled content: Recycled content requirements are applicable to the following when used in the work of this section:
 - .1 Electric Arc Furnace Steel: 75% recycled content minimum, for Rolled Wide Flange Sections, Rolled Channels and Angles, Steel plate, bars and rods.
 - .2 Basic Oxygen Furnace Steel: 20% recycled content minimum for Hollow Structural Sections.

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 SSPC SP1, Solvent Cleaning, The Society for Protective Coatings.
 - .10 SSPC-SP2, Hand Tool Cleaning, The Society for Protective Coatings
 - .11 SSPC-SP6/NACE No. 3, Commercial Blast Cleaning, The Society for Protective Coatings
 - .12 SSPC-SP7/NACE No. 4, Brush-Off Blast Cleaning, The Society for Protective Coatings
 - .13 SSPC-SP10/NACE No. 2, Near-White Blast Cleaning, The Society for Protective Coatings
 - .14 SSPC-SP16, Brush-Off Blast Cleaning of Non-Ferrous Metals, The Society for Protective Coatings
 - .15 ASTM D6386, Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
 - .16 ASTM A780 / A780M Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
 - .17 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.
- .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.
 - .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.

1.7 SUBMITTALS

- .1 Coordinate submittal requirements with Section 01 33 00
- .2 LEED Submittal:
 - .1 Submit require submittals in accordance with Section 01 35 18.
 - .2 Submit documentation to verify compliance with LEED objectives and requirements.
- .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 Calculations – when requested.
 - .9 Do not reproduce the structural drawings to serve as erection or setting drawings.
 - .10 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 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.

.11 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.

.12 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.

.13 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, Fy 345 MPa.
- .10 Uncoated cold-formed steel: ASTM A1011/A1011M Grade 340 (Grade 50), Fy=345 MPa.
- .11 DTM primer/finish: Direct to Metal (DTM) Acrylic Primer/Finish:
 - .1 Acceptable products:
 - .1 Sherwin Williams B66W1 DTM Acrylic Primer/Finish
 - .2 PPG Pitt-Tech 90-712 DTM Primer/Finish
 - .12 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.
 - .13 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
 - .14 Primer for steel to receive Intumescent fireproofing:
 - .1 Coordinate with Section 07 81 23 and Section 09 91 00.
 - .2 Determined to be acceptable based on adhesion and compatibility characteristics under laboratory conditions in accordance with ASTM D3359-09e2, Method A and / or ASTM D4541-09e1, and approved by manufacturer of Intumescent fireproofing to be applied.
 - .15 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.
 - .16 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
- .17 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
 - .2 Section 09 91 01 – Paint Systems and Anti-Corrosion Schedule
 - .3 Section 09 96 13 – High Performance Paint Schedule
- .3 Black Steel
 - .1 No cleaning or painting is required for this steel type.
- .4 Steel to Receive Intumescent Fireproofing:
 - .1 This steel type applies to structural steel exposed to view and to receive an intumescent fireproofing coating:
 - .1 Preparation: Clean structural steel in accordance with SSPC SP6, Commercial Blast Cleaning
 - .2 Coordinate with requirements of Section 07 81 23 and Section 09 91 00.
- .5 DTM Primed/Finished Steel
 - .1 Refer to 09 91 01 for areas of application.
 - .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.
- .6 Primed Steel – Architectural Grade
 - .1 Refer to 09 91 01 for areas of application.
 - .1 Clean structural steel in accordance with SSPC SP6, Commercial 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.
- .7 Primed Steel – High Performance Paint System
 - .1 Refer to 09 91 01 for areas of application.
 - .1 Clean structural steel in accordance with SSPC SP6, Commercial Blast Cleaning.
 - .2 Preparation, shop primers, and field applied paint systems in accordance with Section 09 96 13.
- .8 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.
- .9 Galvanized Steel

- .1 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.
 - .2 Fully galvanize, in accordance with CSA G164 to a minimum zinc coating of 600 g/m².
 - .3 Repair any damage to galvanizing arising from mechanical connections of deck or other attachments using specified cold galvanizing compound in accordance with ASTM A780.
- .10 Galvanized Steel – High Performance Paint System
- .1 This steel type applies to exterior steel that is intended to receive a galvanized coating and a paint finish.
 - .1 Fully galvanize, in accordance with CSA G164 to a minimum zinc coating of 600 g/m².
 - .2 Preparation: Clean steel in accordance with SSPC SP16 Brush-Off Blast Cleaning of Non-Ferrous Metals.
 - .3 Preparation, shop primers and field-applied paint systems in accordance with Section 09 96 13.
 - .11 Provide two coats of heavy bituminous coating on all steel exterior to the building envelope that extends below grade, including where it is encased in concrete.
 - .12 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.
 - .13 Protect all steel from damage during storage, transportation and erection.
 - .14 Protect weep holes at base of closed column sections that have base plates, but no cap plates.
 - .15 During cold weather, protect members from damage due to water freezing in confined areas.
 - .16 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 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.
 - .5 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.
 - .6 New Steel Work to the Existing Building
 - .1 Before proceeding with any work at the existing building, verify that existing members are of the size and in the location indicated on the drawings. If not, do not proceed until the Consultant has given instructions.
 - .2 Make site measurements as required to verify dimensions of existing work before proceeding with the work. The Contractor shall be responsible for extra costs incurred due to proceeding without verifying site dimensions.
 - .3 Adequately shore the existing structure until the permanent structure shown is installed, to ensure that no movements or damage occurs.

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 91 00 and 09 91 01.

.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.

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 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 Cross Laminated Timber Panels, Section 06 17 19
 - .4 Staining and finishing, Section 09 96 00

1.2 LEED REQUIREMENTS

- .1 Comply with the requirements of Section 01 35 18.
- .2 Requirements in Section 01 35 18 pertinent to the work of this section include, but are not limited to, the following:
 - .1 Waste management and disposal: Comply with the waste management plan developed by the Contractor for the work in accordance with Section 01 35 18 Comply with the directions of the Contractor's LEED coordinator with regard to waste management and disposal activities.
 - .2 Construction indoor air quality (IAQ) management: Comply with the IAQ plan developed by the Contractor for the work in accordance with Section 01 35 18. Comply with the directions of the Contractor's LEED coordinator with regard to construction indoor air quality.
 - .3 Low-emitting materials: All adhesives used in the work of this section shall not contain urea-formaldehyde resins or adhesives containing urea-formaldehyde.
 - .4 Certified Wood: A minimum of 75% of the dimensional lumber and plywood used in the work of this section shall meet certified wood requirements.
 - .5 Regional: A minimum of 20% of the materials used in the work of this section shall meet regional material requirements.

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 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.

1.4 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.

1.5 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.

1.6 SUBMITTALS

- .1 LEED Submittal
 - .1 Submit required submittals in accordance with Section 01 35 18.
 - .2 Submit documentation to verify compliance with LEED objectives and requirements.
- .2 Shop Drawings
 - .1 Submit shop drawings in accordance with Section 01 33 23.
 - .2 Shop drawings are to be submitted in PDF format or equivalent, compatible with Adobe Acrobat 9.0.
 - .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.
- .3 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.

.4 Certificates

.1 Submit manufacturer's certification for glulam in accordance with CSA O177.

1.7 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.

1.8 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 05 12 00.
- .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 05 12 00.
- .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 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.

2.2 MATERIALS

- .1 Glue-Laminated Members:
 - .1 Glue-laminated member laminating stock. Conform to the following, unless otherwise noted on the structural drawings: Sustainably harvested Douglas Fir-Larch 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)]

2.3 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. Typical for members with cantilevers.
 - .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: 12c-E. 20f-EX where indicated in the schedule.
 - .4 Tension members including 18t-E
 - .2 Appearance grade: Quality.
 - .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.
 - .5 Modified layup for fire-rating
 - .1 For all bending members indicated on the drawings as requiring a fire-resistance rating, modify the lamination layup as follows:
 - .1 Less than 1 hour rating: no modification required.
 - .2 1 hour rating: remove one core (lowest grade) lamination, move the tension zone inward, and add one additional outer tension (highest grade) lamination to the tension side of the beam.
 - .3 Up to 2 hour rating: remove two core (lowest grade) laminations, move the tension zone inward, and add two additional outer tension (highest grade) laminations to the tension side of the beam.
 - .4 Bending members using a balanced layup (i.e. 24f-EX or 20f-EX) with both top and bottom faces exposed to fire require the modified layup on both top and bottom faces.
- .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.

END OF SECTION 06 18 00

Mechanical Specifications for
Century Gardens Community Youth Hub
342 Vodden Street East
Brampton, ON
JSC Project No. 22-144

Issued for Addenda

Date: February 12, 2024

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Mechanical General Requirements

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
 - .1 This Section applies to and governs the Work of all Mechanical Sections.
 - .2 Where other Mechanical Trades Sections conflict with requirements specified in this Section the Specifications of that particular Section govern.

1.2 Related Sections

- .1 Conform to Section 26 05 00, Common Work Results - Electrical.
- .2 Flashings for mechanical work located on or passing through roof except integral flashing collars on equipment and piping where available as standard or optional component: (Asphalt Roofing).

- .3 Thermal insulation of piping Section 23 07 13 Thermal Insulation for Piping.

1.3 Description

- .1 Provide work in accordance with the full intent and meaning of the Drawings and Specifications as required to result in complete operating systems.

1.4 Apportionment of The Work

- .1 Classify and apportion all materials and the performance of all labour to the several trades involved in accordance with all local customs, rules, regulations, jurisdictional awards, decisions, etc., insofar as they may apply and as required to efficiently execute the work involved in this contract.

1.5 Permits And Fees

- .1 Obtain all permits required for the installation of mechanical trades work, arrange for inspections and tests therewith and pay all fees and costs for the permits, inspections and fees. Obtain permits immediately after notification of award of Contract.
- .2 Obtain copies of Drawings from the Consultant for submission with application for permits.

1.6 Materials And Equipment

- .1 Bear all costs for modification of curbs and floor/roof openings resulting from failure to notify the Consultant prior to the fabrication or construction of opening framing and curb.

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1.7 Submittals

.1 Shop Drawings

- .1 Submit shop drawings in accordance with the General Conditions of the Contract for items hereinafter listed which are exactly as specified. Supplement shop drawings with brochures where necessary or as required. The initial submission of shop drawings for any one trade shall include a checklist of all related specified items for that trade to ensure complete submittal and review.
- .2 Stamp as follows: **SHOP DRAWINGS FOR RECORD PURPOSES ONLY - CHECKED FOR CONSTRUCTION IN ACCORDANCE WITH CONTRACT DOCUMENTS.**
- .3 Record purpose submissions shall include:
 - Plumbing Fixtures
 - Plumbing Specialties
 - Piping Specialties
 - Electric Starters
 - Access Doors
 - Isolating Unions
 - Caulking Compounds
 - Pipe Sleeve Seals
- .4 Submit seven copies of such Drawings or Brochures to the Consultant, who will review such Drawings or Brochures. If items are not as specified, re-submit five corrected copies.
- .5 Submit Shop Drawings (1 sepia and 2 prints) for all other mechanical equipment in accordance with the requirement outlined in the General Conditions of the Contract.
- .6 Prepare Shop Drawings specifically for this work by qualified drafters and in sufficient detail to avoid decisions being made in the shop or field.
- .7 General Shop Drawings showing more than one size or model will not be considered unless properly marked up.
- .8 Include performance data and characteristic curves with all fan and pump Shop Drawings.
- .9 Submit Shop Drawings for suspension systems for all suspended equipment. Indicate the location of suspension for the equipment, the maximum load at each of the suspension points, the size of suspension rods or members and details of supplementary structural steel framing members.
- .10 Include wiring diagrams and schematics for all equipment which has electrical controls or devices furnished with the equipment. Wiring diagrams alone are not sufficient; schematic and interconnecting drawings, and sequence of operation of equipment are required for review.

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- .11 Clearly indicate the materials and/or equipment being supplied, all details of construction, finish, accurate dimensions, capacities and performance on Shop Drawings and brochures. Have all drawings certified correct for construction by the manufacturer, before submission. Identify equipment Shop Drawings with designations as shown on the Drawings or in the Specifications. If not complied with, Shop Drawings will not be reviewed and will be returned to the Contractor.
 - .12 Each Shop Drawing and/or brochure must bear the stamp and signature of a responsible official in the Contractor's and the subcontractor's organization for each submission as evidence that the drawing has been checked against the requirements as called for in the specifications and Drawings. Also, in the case where the equipment attaches to and/or where there is external wiring connecting to other equipment, that it has been properly coordinated with this equipment, whether supplied under this or other contracts.
 - .13 Revisions to shop drawings will not be allowed after they are reviewed unless further review and submission is required.
- .2 **Interference & Detail Drawings**
- .1 Make Interference Drawings in conjunction with all parties and trades concerned showing sleeves and openings and passage of piping and ductwork through building structure. Drawings shall also show inserts, special hangers and other features to indicate routing through confined spaces, installation of coils, silencers and other such items in such areas.
 - .2 Provide 1:25 scale Detail Drawings, fully dimensioned, of piping, ducts and equipment in shafts, Boiler and Mechanical Equipment, Service and Fan Rooms. Base equipment drawings on "Reviewed" Shop Drawings and include, but do not necessarily limit to, details pertaining to access, clearances, tappings, sleeves, electrical connections, drains and service spaces and integral control drawings.
 - .3 Provide Detail Drawings of sump pits, equipment bases, anchors, inertia slabs, floor and roof curbs pertaining to this Division.
- .3 **Record Drawings:** Maintain an accurate dimensional record of all underground piping and all deviations and changes in above ground piping, ductwork and equipment from the Contract Drawings. Transfer this information to two (2) sets of record drawings filed at the job site and submit to the Consultant at the completion of the job. Provide electronic copies of as-built drawings stored on 2 sets of CDs.
- .4 **Installation and Start-up Instructions:** Furnish three copies of installation instructions and three copies of start-up instructions for any item of equipment when requested by the Consultant.

Mechanical General Requirements

.5 Operating and Maintenance Instruction Manuals

- .1 Provide two copies of complete operating and maintenance instructions for equipment furnished under this Contract.
- .2 Bind instructions in loose-leaf 3-ring binders. When only one volume is required, provide a complete index. When more than one volume is required, include in the first book a complete index of all volumes and an individual index in each succeeding volume. Include the following manuals:
 - Schematic diagram of pneumatic, electrical, oil and/or gas systems.
 - Control Shop Drawings and operating sequence including wiring of components.
 - Wiring diagram of control panels.
 - Non-dimensional layout showing location of all electrical devices on mechanical equipment.
 - Operating instructions, including start-up and shut-down procedure.
 - Maintenance instructions including preventive maintenance instructions for components of the equipment.
 - Lubricating instructions and recommended cycle of lubrication for each item of equipment, including various types of lubricants.
 - Complete parts list of assemblies and their component parts, showing manufacturer's name, catalogue number, and nearest replacement source.
 - List of recommended spare parts and quantity of each item to be stocked.
 - Manufacturers' warranties and guarantees.
 - All the above applies to component parts of equipment whether they are manufactured by the supplier of the equipment or are supplied as a component part of an item of equipment.

.6 Schedules

- .1 Within one month of contract award, provide a schedule of the work indicating the following:
 - .1 Intended sequence of work items.
 - .2 Start dates of individual work items.
 - .3 Duration of individual work items.
 - .4 Planned delivery dates for major material and equipment and expected lead times.
 - .5 Milestones indicating possible restraints on work by other trades or situations.

.7 Training:

- .1 Mechanical Contractor shall arrange for training of Owner's Maintenance Personnel on the operation of all Mechanical and Control Systems.

Mechanical General Requirements

1.8 Quality Assurance

.1 Regulatory Requirements

- .1 Conform to governing Municipal or Federal Codes, Rules and Regulations and/or Authorities having jurisdiction.
- .2 Codes and Standards referred to hereinafter are by inference, in each case, the latest issue of the Specified Code or Standard, including all revisions and amendments thereto as adopted and published at date of tender closing.
- .3 Do all work and supply all equipment in accordance with the requirements and recommendations of the latest issue of the applicable standards and codes of the:
 - National Standards of Canada (NS Can)
 - Canadian General Standards Board (CGSB)
 - Canadian Standards Association (CSA)
 - Canadian Building Code O.Reg. 403/97, as amended
 - Canadian Fire Code
 - Ministry of Labour
 - Sheetmetal and Air Conditioning Contractors' National Association (SMACNA)
 - National Research Council Canada – Model Energy Code of Canada for Buildings 1997
 - American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) Standard 90.1-2001 - Energy Standard For Buildings Except Low-Rise Residential Buildings.

1.9 Warranty

- 1 **Furnish to the Owner through General Contractor and Consultant, written warranty covering materials and workmanship and free service for two years from date of start of substantial performance.**
- .2 Warrant apparatus installed to properly operate, cool, heat and ventilate without undue noise through every item of equipment and system and to maintain required room conditions. Filters in all air handling equipment shall be replaced at substantial completion and one month after occupation of the facility. Cost of these replacement is to be included in the Mechanical Contract. Contractor shall, one month after occupation check and clean strainers as required.
- .3 Warranty shall entail repair or replacement of materials installed without charge to the Owner except where, in opinion of Consultant, such repair or replacement was caused by improper use or lack of proper maintenance.

Mechanical General Requirements

1.10 Electrical Requirements

.1 General

- .1 Comply with the requirements of the Electrical Safety Code.
- .2 All equipment specified in Mechanical Specification or shown on the Mechanical drawings to be supplied and installed by the Mechanical Contractor and wired by the Electrical Contractor unless specifically indicated otherwise. Generally, all wiring above 50 volts by the Electrical Contractor and all low voltage control wiring below 50 volts by the Mechanical Contractor unless otherwise indicated.
- .3 The nominal electrical service available for mechanical equipment is 208 volts 3 ph, 60 Hz, and 120 volts, 1 ph, 60 Hz, unless specifically stated otherwise on the Drawings.
- .4 Provide motors with all electrically driven equipment furnished under this Contract.

.2 Motors

- .1 Provide motors of 0.37 kW and larger having a nameplate rating of 575 volts, 3 ph, 60 Hz, and motors of 0.25 kW and less with a nameplate rating of 115 volts, 1 ph, 60 Hz, unless otherwise specified hereinafter or otherwise shown on the drawings.
- .2 For types of motors required for this project refer to and comply with requirements of Electrical Division.
- .3 Use motors of 0.7 kW and larger that are approved by the Canadian Safety Code.
- .4 All motors must meet the minimum nominal efficiency requirements of CSA C390-98.

.5 Fan Motors must be capable of variable system flow as prescribed by MNECB1997 and ASHRAE 90.1-2001. Refer to Mechanical Specifications.

.3 Starters, Disconnects, Motor Control Centres, etc.:

- .1 Manual motor starter shall be toggle operated with following general construction features:
 - Quick-Make, Quick-Break mechanism with double-break contracts.
 - Overload protection heaters, one per phase and speed.
 - Enclosure to suit application.
 - Pilot light, neon lamp.
 - Cover engraved with "On-Trip-Off".

Mechanical General Requirements

- .2 Magnetic motor starters shall comprise electrically-operated motor starters combined with disconnect switch with following general construction features:
 - Quick-Make, Quick-Break mechanism with double-break contacts.
 - Fuse holders to accept specified fuses, one per phase.
 - Adjustable overload relays, one per phase.
 - CEMA listed enclosure to suit application. Disconnect with mechanical cover interlocks, line side barriers and switch operated electrical interlocks to disconnect external control voltage unless starter includes suitable approved enclosed contacts and connections.
 - "Reset" button.
 - Pilot Lights of transformer type incandescent with amber safety lens cap.
 - Control transformer with 120 volt fused secondary and sized to suit current rating of associated control devices.
 - Scheduled cover mounted control devices with standard duty double break contact blocks.
 - Minimum of two auxiliary contacts (unused "Seal-in" contact may be included).
- .3 Contactors for non-motor applications shall be built similar to combination magnetic starters, except less overload relays, and with Gould Shawmut AJT time delay HRC1-J fuses, rated for load, and with enclosed continuous current rating of at least 125% of connected full load.
- .4 "Double Voltage Relays" shall be CGE Model CR120 LXMC with general purpose enclosure, number of contacts required and "Mylar" shroud of enclosure of contacts, or approved equivalent.
- .5 Pilot devices such as "Start-Stop" pushbuttons, "Hand-Off-Auto" selector switches and indicating lights shall be of heavy-duty construction. Indicating lamps shall be transformer type incandescent with amber safety lens caps.
- .6 Each control unit shall be provided with engraved nameplates for designation of device controlled and duty. See Subsection "Equipment Markers & Nameplates" for details.
- .7 Safety control device such as flow switches, pressure switches, high and low limited ("Fire" and "Freeze") shall not be shunted by "Hand" position of switch.
- .8 Control wiring shall be 120 volt A.C. maximum. Provide control circuit transformers where these are not included in motor starters. Secondaries of control transformers shall be fused with one side grounded and controls, safety devices and interlocks shall be connected in ungrounded conductor, excepting only integral starter overload devices.
- .9 Single phase motors interlocked to start or operate with other equipment shall be provided with magnetic starters or suitable relays with necessary auxiliary contacts and double voltage relays or be otherwise electrically separated.

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- .10 Overload relay heaters for starters shall be selected and field adjusted to trip at maximum value of 115% of actual nameplate full load amperes. Selection of heater elements shall be based on starter manufacturer's recommendations. Obtain data from Mechanical Division. Submit Motor Starter Schedule which shall list following for each motor:
- Proposed equipment nameplate data
 - Actual full load amperes of motor
 - Speed of motor
 - Temperature Class in degrees Celsius rise and insulation class.
 - Circuit breaker or fuse type and proposed rating
 - Type of motor, duty and service factor.
- .11 Overload relay heaters shall trip in 20 seconds or less from cold or motor-locked rotar condition.
- .12 Where equipment is noted to be electrically interlocked, provide necessary interlocks, double voltage relays (Mylar shroud accepted) to provide specified operation.
- .13 Provide all fuses required to protect equipment. Fuses shall be proper size blade type time delay HRC1-J current limiting. Supply three spare fuses of each size and type and obtain duplicate receipt for same. Fuse clips shall reject standard NEC fuses. Fuses shall be rated in accordance with manufacturer's published data. Fuses to be of one manufacturer throughout.

.4 Identification of Electrical Equipment: As specified in Section 26 05 00.

.5 Identification of Motors: Provide all motors with brass tags attached by small chain loop, bearing the equipment identification of the driven equipment as described on the Mechanical Equipment Schedules. Stamp or engrave identification information with lettering of 9 mm (d") high min.

.6 Wiring: Provide power and control wiring as defined under respective Sections of Mechanical and Electrical Divisions. Refer to and conform with Sections 26 05 00 for details of raceways, boxes, wiring, colour coding, etc.

PART 2 - PRODUCTS**2.1 Drives and Accessories****.1 Drives**

- .1 Select v-belt drives for 150 percent of the motor size rating. Provide sheaves of cast iron construction with machined grooves. Provide sheaves of 75 mm (3") size and larger diameter with taper lock bushings. Statically and dynamically balance all sheaves as an operating unit. For multi-belt drives use matched sets.

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- .2 Provide adjustable pitch sheaves on motors of less than 11 kW rating, with diameter range selected to obtain specified RPM of the driven equipment at approximately the mid-point setting of the sheave.
 - .3 Provide solid type drive sheaves on motors of 11 kW and greater. Should such sheaves not provide design requirements under operating conditions, supply and install a new drive sheave of proper size at no additional cost to the Minister.
 - .4 Submit drive data with Shop Drawings of each item of driven equipment.
- .2 Lubricating Devices
- .1 Furnish equipment with oil reservoirs with level indicators, or pressure grease fittings. Where fittings are not readily accessible, provide extended tubes to an accessible location. Grease fittings may be Zerk or Alemite but all fittings on the project shall be one type.

2.2 Pipe Sleeve Seals

- .1 Thunderline "Link-Seal" Series LS
- .2 Fernco
- .3 Thermacor

2.3 Bonding Agents

- .1 Sika "Sikadur 32" Hi-Mod
- .2 Probond
- .3 Dupond

2.4 Motors, Starters, Disconnects

- .1 Canadian General Electric
- .2 Klockner Moeller
- .3 Cutler hammer
- .4 Furnas Electric
- .5 Square 'D'

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2.5 Access Doors

- .1 E.H. Price
- .2 Titus
- .3 Controlled Air
- .4 Williams (S.M.S.)
- .5 Acudor

2.6 Isolating Unions

- .1 Epco
- .2 Marpac "Petro"
- .3 Corrosion Service

2.7 Caulking Compounds

- .1 Denso-Plast
- .2 Ecco Shield
- .3 CBR

PART 3 - EXECUTION

3.1 General Construction Requirements

- .1 General
 - .1 Conform with applicable requirements of the Occupational Health and Safety Act and Regulations for Construction Projects, Ontario Regulation 213/91 Amended to O. Reg 527/00.
- .2 Measurements and Deviations
 - .1 Where any parts of the mechanical work are specifically located by dimensions on the Drawings, check and verify these dimensions on the site prior to installation.

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- .2 Before installing piping, review architectural, structural and electrical drawings with mechanical drawings. Where interference may occur and departures from arrangements as shown are required, consult with other trades involved, come to agreement as to changed locations or elevations and obtain approval of the Consultant for proposed changes before proceeding with the work.
 - .3 Examine work of other trades or contractors, prior to commencement of mechanical installations. Report in writing, to the Consultant, any discrepancies which will affect mechanical installations. Failure to do so shall be considered acceptance of the conditions.
 - .4 Where Site conditions require minor deviations from indicated arrangements or locations, make such changes on approval of the Consultant without additional cost to the Consultant.
 - .5 Should any discrepancies occur during installation of mechanical work which will necessitate major revisions to the mechanical trades work or the work of other trades or contractors, notify the Consultant immediately and obtain his written authorization before proceeding with the work.
- .3 Scaffolding and Hoisting Equipment
- .1 Refer to and comply with the requirements of 01 5100, Temporary Utilities and Controls.
 - .2 Do not drill, cut or weld the building steel or building structure for erection of materials or equipment without prior written approval of the Consultant.
- .4 Overloading
- .1 During installation of mechanical work, do not load any part of the building structure with a load greater than it is capable of bearing. Bear full responsibility should any accident occur or damage result through the violation of this requirement.
 - .2 Any temporary supports used during installation must be as strong as permanent supports.
- .5 Attachment to Building Construction
- .1 Use welding studs of size not larger than 10 mm for attaching miscellaneous materials and equipment to building steel. If the weight of materials or equipment require bolts or studs larger than 10 mm dia., use steel clips or brackets, secured to building steel by welding or bolting as approved by the Consultant.

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- .2 Use self drilling expansion type concrete inserts for securing miscellaneous equipment and materials to masonry or concrete construction already in place, of sufficient number and size to prevent concrete from breaking away. The use of powder or power actuated fasteners will not be allowed unless prior written approval is obtained from the Consultant.
 - .3 Support rods for any suspended item must not be attached to or extended through steel pan type roofs or through concrete slab roofs.
 - .4 Furnish beam clamps of 2-bolt design and of such type that the rod load is transmitted only concentrically to the beam web centreline. The use of "C" and "I" beam side clamps, etc., will not be allowed without written consent of the Consultant.
 - .5 Where the roof or floor framing consists of open web or long span steel joists, ensure that hangers are located at or within 150 mm of the joist top or bottom chord panel points, otherwise provide additional structural steel as required where hanger spacing does not coincide with joist spacing. Design suspension assembly such that the hanger load is transmitted only concentrically to the supporting joist. Do not use "C" and "I" beam side clamps, brackets, etc., without written consent of the Consultant.
 - .6 Locate secondary structural steel members between joists at or within 150 mm of top or bottom chord panel points. Where the secondary structural steel member cannot be located at or near a joist panel point, provide additional diagonal structural steel web member/members designed for the applicable load to the nearest panel point in the opposite chord member. This condition may be waived if the load to be suspended between panel points is not in excess of 45 kg. Diagonal hangers which will induce lateral stresses in the chord members of the joist will not be permitted. Submit shop drawings of the suspension assembly indicating the location of suspension or support points, the maximum load at each suspension point, location and size of hangers, brackets and intermediate framing members when required, and also details of connection to building structure.
- .6 Cutting, Patching, Excavation and Backfill
- .1 Cutting of holes up to 200 mm in diameter and related patching shall be done under Mechanical Division. Holes and other openings larger than 200 mm in diameter, all chases, bulk-heads, furring and related patching shall be done under Section 01 73 03, Execution Requirements. Read same for detailed information regarding cutting and patching.
 - .2 Do not cut, remove or burn structural parts or sections of the building, whether they are steel, concrete or masonry, without the written authorization of the Consultant.

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- .3 Should cutting, repairing, and patching of previously finished work of other trades be required to allow installation of mechanical work, pay all costs for the trade concerned to perform the work.
- .4 Perform necessary excavating for work of this Division. Ensure bottoms of trenches are excavated so that full length of each pipe will be supported on solid bed of undisturbed earth. Build approved concrete pad, solid block or concrete piers properly reinforced under piping below grade where solid undisturbed earth bed is not obtainable to meet Plumbing Code.
- .5 Remove excavated materials not used as backfill from site unless otherwise directed.
- .6 See Soil Test Report re existing soil conditions. Support all piping on approved earth or other foundation or hangers. Earth support must be minimum 90% density Modified Proctor (ASTM #D-1527) compaction and proven such conditions exist. Include for necessary soil tests to verify earth foundation will support drains as required at approximately 2400 mm centres. Provide supports to meeting Plumbing Code, Section 51 including piers where earth foundation or hangers are not acceptable to Consultant or authority having jurisdiction.
- .7 Where permitted by authority having jurisdiction where pipe invert is less than 900 mm below floor elevation steel clevis hangers, steel rods and continuous steel supports from floors at half normal spacing may be used. Paint all buried metal hanger work with 2 coats of Bakelite #110-14, Radyne and Ductile.
- .8 Provide necessary shoring and support for trenching. Do all work in conformity to Ontario Trench Excavator's Protection Act and Occupational Health & Safety Act, each as amended to date. Trench widths shall be kept to minimum dimension as directed & approved.
- .9 Perform necessary pumping to maintain excavations free of water for work of this Division until backfill is completed.
- .10 Provide 100 mm bed of 20 mm crusher run limestone compacted to 98% Modified Proctor under all piping not laid in sandy ground or other approved bedding. For copper and plastic piping, bedding shall be clean sand.
- .11 Backfill at least first 150 mm above top of piping with clean coarse sand hand placed in 75 mm layers and compacted to 98% density Proctor Modified (ASTM #D1527). Note conditions and Details and conform thereto.
- .12 Backfill inside building with M.T.C. granular 'B' or clean coarse sand in 150 mm layers mechanically compacted to give minimum of 98% density Modified Proctor (ASTM #D-1527 STD) compaction.

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- .13 For Landscape Areas: Backfill outside building with approved clean earth in 300 mm layers watered and compacted to 98% Modified Proctor. Do not use clay, rock, frozen earth, rubbish or other unapproved materials. Remove same from site and bring in approved earth or sand for use in this event.
- .14 Backfill under all existing, new and future concreted, paved or gravelled areas with M.T.C granular 'B' placed in 150 mm layers and compacted to 98% Modified Proctor Compaction to level of sub-base of paving or gravel.

3.2 Equipment Installation

.1 General

- .1 Erect equipment in a compact, neat and workmanlike manner. Align, level and adjust for satisfactory operation. Install in such a manner that connecting and disconnecting of piping and accessories can be made readily and that all parts are easily accessible for inspection, operation, maintenance and repair.
- .2 Install and start up items of equipment in complete accordance with the manufacturer's printed installation and operating instructions.SPEC. NOTE ProSet Fire Penetrators systems (merican products distributed by Firestop Strategies) consist of patented PVC fire-resistant couplings, ULC tested, that can be cast-in-place in concrete or fitted in standard size cored hole. These zcomponents then become integral part of the drainage, vent, conduits or other piping systems. Use of these systems in Project requires 'extensive' coordination between work of Division 3 (concrete), Division 7 (firestopping) and Division 15.

.2 Firestopping and smoke seal

- .1 Be responsible for installation of firestopping and smoke seal inside mechanical assemblies (i.e. fire dampers).
- .2 Firestopping and smoke seals around outside of mechanical assemblies, where they penetrate fire rated separations shall be part of work of Section 07 8400, Penetration Firestopping and shall be carried out under supervision of this Division.
- .3 Be responsible for any additional cost incurred as a result of oversizing of openings during cutting and patching operation of openings to be firestopped up to 200 mm (8") in diameter
- .4 Install sheet steel covers supplied by Section 05 50 00, Metal Fabrication over temporarily unused sleeves provided in fire separations for future mechanical installations.

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- .5 Noise and Vibration: Select noise and vibration levels of equipment and systems to conform to design intent. If unnecessary noise or vibration should be created by any mechanical equipment and systems and transmitted to occupied portions of building or other mechanical work, make all necessary changes and additions as approved by the Consultant without additional cost.
 - .6 Lubrication: Lubricate all equipment prior to start up, in accordance with the manufacturer's printed instructions. Provide all lubrication including sufficient quantity for drainage and refilling of oil sumps, etc., when required by manufacturer's instructions.
- .3 Equipment Bases and Pads
- .1 Verify size of bases shown on Drawings with actual requirements and advise the Consultant and the respective trades if change in size or shape of pad is required.
 - .2 Construct bases and pads at least 150 mm high unless specifically stated or shown as less on the Drawings or directed by the Consultant. Extend bases 75 mm beyond centreline of anchor bolts or to a minimum of 50 mm beyond equipment base. Chamfer all upper perimeter edges of base.
 - .3 Supply anchor bolts and sleeves to trade constructing bases in sufficient time for setting in formwork prior to placing concrete and provide anchor bolt location drawing or template for locating anchor bolts. Check anchor bolt locations for proper position before concrete is poured.

3.3 Piping Construction Methods

- .1 General
- .1 Unless specified otherwise herein, construct and install all piping in accordance with ANSI Sections B31.1 to B31.9 as applicable to service, except that soldered joints will not be permitted in compressed air piping.
 - .2 To avoid unnecessary cutting of masonry, provide inserts, sleeves and anchors to other trades for building in as the work proceeds. Arrange with other trades to leave openings, slots and chases to accommodate later installation of mechanical work.
 - .3 Inspect pipe and fittings for soundness and clean of all dirt and other foreign matter immediately prior to installation. Reject all damaged items.
 - .4 Install piping in the most direct, straight and functional manner possible. Except where otherwise shown, install all vertical lines plumb, and run horizontal lines parallel to building walls. Install piping close to walls, partitions and ceilings. On multiple runs of piping, space piping to allow for installation of insulation and for proper servicing of valves.

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- .5 Ensure that trenches for piping below grade are dry and firm when laying pipe.
 - .6 In fill areas, provide a minimum clearance of 100 mm (4") on all sides of the pipe passing under or through building grade beams to prevent possible damage from settling of building. If a greater settlement can be expected, increase the clearance to prevent possible damage.
 - .7 Conceal all piping in finished areas and rooms within walls or ceilings, and in furred spaces elsewhere. Provide access doors or panels as hereinafter specified for access to concealed piping specialties etc.
- .2 Expansion and Contraction
- .1 Install all piping so as to be free from strain and distortion due to expansion and contraction and governed by requirements of Section 6, Chapter 3 of ANSI B31.1, except as hereinafter modified. Allow for expansion and contraction by offsets, expansion U-bends or loops. Do not use expansion joints of any type unless specifically indicated on the Drawings or specified under another Section of Mechanical Specifications for a particular installation.
 - .2 Base provision for expansion and contraction on 25 mm movement per 30 m of steel pipe and 38 mm movement per 30 m of copper or brass pipe for each 55 de C temperature difference from 21 deg C ambient. Fabricate expansion bends in steel pipe from pipe sections and long radius welding elbows.
 - .3 Use swing or swivel joints on all steam or hot water heating piping for connections from mains to risers and from risers to radiation and other heating units. Use at least five fittings from main to riser including tee in main. Use at least four fittings from riser to heating unit including tee in riser.
- .3 Lines, Grades and Slopes
- .1 Install piping in conformity with elevations and grades indicated on the Drawings using axis lines and bench marks provided under General Construction; verify such axis lines and bench marks. Each trade shall lay out his work and be responsible for lines, elevations, measurements, etc., required for installation of his work.
 - .2 Slope piping drains and sewers as indicated on the drawings. Install so that slope between elevations shown on the Drawings is even and constant.
 - .3 Install liquid and air lines free of pockets and pitch to drain at low points in the line with valves or traps installed as required for drainage of the lines.

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- .4 When slope is not shown on the drawings, install piping to the following slopes:
- Drainage piping - 1:50 on drains of NPS 3" size and less and 1:100 on drains of NPS 4" and larger. In special circumstances as provided for under the Codes and Regulations and the express approval of the Consultant, drains of NPS 4" size and larger may be laid at a lesser slope.
 - Domestic water lines - pitch to low points so that all lines may be completely drained.
 - Natural gas - slope down 1:1000 in direction of flow.

.4 Immersion Wells and Sensing Bulbs

- .1 Where a temperature sensing bulb or immersion well is installed in piping of NPS 22" size and less, increase the tee fitting and piping as required in which the bulb or well is inserted a minimum of one pipe size larger than the adjoining pipe to prevent restriction of flow of liquid.
- .2 To improve heat transfer pack all immersion wells in piping for liquids up to a temperature of 150 deg C with a mineral type grease prior to installation of sensing bulb.

.5 Pipe Joints

- .1 Ream all pipe ends and thoroughly clean all dirt, cuttings and foreign matter from pipe after cutting and threading. Thoroughly clean all fittings, valves and equipment before connections are made. Cut copper tubing with a tube cutter and clean the joining surfaces of the tubing and fitting with fine emery cloth. Wipe clean with a dry cloth.
- .2 Make screwed joints with Teflon tape or Masters metallic compound with the compound applied to the male threads only and particular care taken to prevent the compound from reaching the interior of the pipe or fittings.
- .3 Install sleeve type couplings for cast iron plain end soil pipe, such as Titan Foundry Type MJ, or Bibby MJ Series 2000 or Dayton in strict accordance with manufacturer's printed instructions.
- .4 Make joints on cast iron bell and spigot soil pipe with either neoprene compression type preformed gaskets such as Bibby "Bi-seal", or lead and oakum with a minimum of 0.5 kg of lead per 25 mm of pipe diameter, and caulk in such a manner to produce a permanently tight joint. Cold caulking compound in cord form such as W.R. Meadows PC4 may also be used. Assemble preformed neoprene gaskets to manufacturer's printed instructions.
- .5 Assemble mechanical joint on ductile iron pressure pipe with cast iron gland, rubber sealing gasket and high strength malleable iron bolts in accordance with the manufacturer's recommendations.

 Mechanical General Requirements

- .6 Install couplings, fittings, etc. on grooved end piping systems in accordance with manufacturer's printed instructions.
- .7 Make soldered joints on copper tubing in accordance with the following usage:
- | | <u>Service</u> | <u>Solder Type</u> |
|----|-------------------------|------------------------------|
| .1 | Dom. Hot and Cold water | lead free with matching flux |
| .2 | Drain, Waste, Vent | 50/50 with matching flux |
| .3 | Hot water heating | 95/5 with matching flux |
- .8 Do not use core type solder. Use solder conforming to ASTM requirements.
- .9 Make carbon steel welded joints in compliance with latest acceptable practices, either by electric arc welding, gas metal arc welding, or oxy-acetylene gas welding.
- .10 Employ qualified welders holding a current up-to-date Provincial Certificate for the process and rating involved as required by the Provincial Regulations.
- .11 Conform to ANSI B31.1 Section IX for welding and be responsible to ensure that supervisory staff, fitters and welders are fully conversant with the requirements laid down by that Standard prior to the commencement of welding.
- .12 Unless more stringent methods of inspections are specified the Consultant will visually inspect welded joints for fusion of metal, icicles, alignment, etc. Remove any defects and remake the joint to his satisfaction.
- .13 For welding of materials other than carbon steel conform to the requirements specified in the relevant section of the Specification.
- .14 Subject all steam, condensate, nitrogen and airlines to a 10% radiography of welded joints in accordance with ASME Boiler and Pressure Vessel Code, Section V.
- .15 If more than the allowable number of welds prove to be unacceptable pay all costs for a complete radiographic test of all joints in the affected piping system.
- .16 Re-weld and re-test unacceptable joints at no additional cost to the Owner.
- .6 Unions and Flanges
- .1 Provide unions or flanges in the following locations:
- For bypasses around equipment or control valves or devices in piping systems.
 - At connection to steam traps and in by-passes around traps.
 - At connections to equipment. Locate between shut-off valve and equipment.
 - In screwed or solder joint drainage tubing at inlet side of trap.

Mechanical General Requirements

- .2 Do not conceal unions in walls, partitions or ceilings unless access thereto is provided.
- .3 Provide dielectric unions or isolating type companion flanges at all connections between copper tubing and ferrous piping.
- .4 Assemble flanged joints with appropriate flanges, gaskets and bolting. Provide clearance between flange faces such that the connections can be gasketed and bolted tight without undue strain on the piping system with flange faces parallel and bores concentric. Centre gaskets on the flange faces so as not to project into the bore. Lubricate bolts before assembly to assure uniform bolt stressing. Machine off raised face flanges when joining to a flat companion flange and use a full face gasket.

.7 Fittings

- .1 The use of couplings between fittings, valves or equipment, will not be permitted except on long runs in pipe sizes NPS 2" or smaller. Where the length of pipe between fittings requires a connection, make the joint by welding. Do not use running couplings in any pipeline.
- .2 Fittings and ancillary items installed in systems operating at pressures in excess of 103 kPa (15 psig) must be registered in accordance with CSA B51.
- .3 Use eccentric reducing fittings in locations where piping changes size and at connections to equipment and control valves, to provide proper drainage or venting of the lines. Do not use bushings.
- .4 Tee connections in welded piping may utilize either of the following:
 - Factory fabricated standard buttweld fittings.
 - Bonney Forge "Weldolets", "Thredolets" or "Sokolets".
- .5 Mitering, notching or direct welding of branches to mains, will not be permitted.
- .6 Use standard pipe fittings for changing direction of piping. No mitered joints or field fabricated pipe bends are permitted. Use long radius welded steel elbows unless short radius elbows are specifically authorized by the Consultant.
- .7 In copper tubing, direct connection of branch into main using "T-Drill" method may be used where allowed by Ontario Building Code.

.8 Piping Connections to Mains

- .1 Make branch connections of steam, gas and compressed air lines to respective horizontal piping of larger diameter to the upper quadrant of the larger pipe.
- .2 Make down feed piping connections of all water piping to horizontal supply and return mains to the bottom quadrant of the mains.

Mechanical General Requirements

.9 Sleeves

- .1 Install sleeves where piping passes through foundations, above grade floors and walls. Fabricate sleeves of Sch. 40 black steel pipe or type "K" copper tubing for installation in foundations or floors, and of 1 mm (20 ga.) galvanized sheet steel where installed in above grade walls.
- .2 Sleeves for piping passing through roofs will be supplied and installed under other Contracts or under Roofing Section, unless specifically shown otherwise on the Drawings.
- .3 Make sleeves large enough to pass full thickness of pipe covering where same is used, and with sufficient clearance between pipe and sleeve to allow for any lateral movement of piping due to expansion and contraction.
- .4 Terminate sleeves flush with finished ceilings, walls and floors on grade. For piping passing through floors above grade extend sleeve a minimum of 75 mm above the floor.
- .5 For pipes entering structures from below grade, seal the annular space between sleeve and pipe with prefabricated seals.
- .6 In the case of pipes passing through firewalls or through walls, partitions or floors which are considered as serving as fire stops and in partitions around washrooms, seal the space around the pipe, in the sleeve.
- .7 Fill sleeves for future use with lime mortar.
- .8 Assume all responsibility for the setting of all sleeves necessary for this work in masonry walls during construction or in concrete forms before concrete is poured.
- .9 Coat exterior surface of all sleeves of ferrous material with a heavy asphalt emulsion.
- .10 Firestopping shall be installed and applied as required by NBCC and FMOG-ENG-4003. Fire stopping shall be in accordance with CAN/ULC-5115: Fire tests of Firestop Systems.

.10 Escutcheon Plates

- .1 Provide escutcheon plates on bare piping passing through finished walls or floors.
- .2 Use escutcheon plates made of cast brass or stamped metal, either one to be heavy chromium plated and, if constructed in two pieces, fitted with substantial hinges and positive latches. Provide plates with tempered springs to ensure positive attachment to the pipe.

Mechanical General Requirements

.11 Valves

- .1 Supply and install valves in all locations shown on the Drawings, at all piping connections to equipment, at all connections to control valves or control devices, and where required for sectionalizing a system or floor.
- .2 Use gate or butterfly valves for shut-off purposes and globe or plug valves for throttling purposes.
- .3 Install check valves wherever required to ensure flow of liquid in one direction.
- .4 Provide drain valves with hose thread outlet connection or valve with long nipple on outlet at all low points of each water system and above all riser or branch stop valves for proper drainage of lines.

.12 Piping Subject to Freezing

- .1 Where horizontal or vertical piping is run along an outside building wall and concealed in a pipe space, circulation of interior air shall be maintained in the pipe space by means of air grille(s) located at the top and bottom of pipe space, facing the interior of building.
- .2 Where horizontal piping is run in a ceiling space under uninsulated roof, the insulated pipe shall be encased in slab insulation on both sides and top and circulation of interior air shall be maintained in the encasement by means of air grilles located in the ceiling below, facing down into the interior of the building. The spacing of grilles shall be not less than 3000 mm o.c.

- .13 Air Venting: Install all vents at high points of all water piping systems and connect to nearest drain.

3.4 Miscellaneous Steel

.1 Painting and Cleaning

- .1 Touch up minor damage to finish on equipment with standard factory applied baked enamel finish. If, in the Consultant's opinion, the damage is too extensive to be remedied by touch up, replace damaged equipment.
- .2 Clean steel by scraping, wire brushing or other effective means to remove base scale, rust, oil, dirt or other foreign matter.
- .3 Apply one coat of zinc chromate iron oxide primer, conforming to CAN/CGSB-1.40M to all miscellaneous steel.
- .4 In the field, touch up all bolt heads and nuts, previously unpainted connections and surfaces damaged during erection with primer as hereinbefore specified.

Mechanical General Requirements

.5 Give two coats of primer to all surfaces which will be inaccessible after erection.

.6 Thoroughly remove all foreign matter from steelwork on completion of installation.

3.5 Concrete Inserts

.1 Install all inserts required for attachment of hangers, either for suspension of piping or equipment.

.2 For masonry or poured concrete construction use expansion type units. Insert into the concrete after concrete has cured. Anchors or inserts installed by explosive means shall not be used.

3.6 Flashings

.1 Furnish and set all required counter-flashings for vent stacks.

.2 For safety vents, plumbing vents and all other pipes passing through roofs, stack flashings will be supplied and installed by roofing trade.

3.7 Access Doors

.1 Access doors in ductwork are specified in Section 23 33 00 Ductwork Accessories.

.2 Supply access doors for installation by other trades in walls or ceilings where accessibility is required for the operation and/or maintenance of concealed valves, traps, cleanouts, dampers and control equipment. Unless otherwise specified on the Drawings or in other divisions of the Specifications, or as required to replace or repair said equipment, provide access doors at least 200 mm x 200 mm (8" x 8") size, fabricated of bonderized steel, with concealed hinges and screwdriver lock. Provide doors of a type and fire rating to suit the particular type of wall or ceiling construction in which they are to be installed.

3.8 Protection

.1 Protect all work and materials before and after erection from weather and other hazards and keep in a clean and orderly manner.

.2 Protect pipe ends, valves and parts of equipment left unconnected to prevent damage or intrusion of foreign matter. Provide pipe caps for threaded male connections and plugs for threaded female connections.

.3 Protect plumbing fixtures or mechanical equipment having a baked enamel finish by covering with polyethylene sheet securely held in place.

Mechanical General Requirements

3.9 Painting

- .1 With the exception of prime painting of miscellaneous steel or any other specific requirements as specified under the respective Sections of the Mechanical Trades Work, or equipment otherwise factory painted, all painting will be provided under General Trades Work.

3.10 Sterilization Of Potable Water Systems

- .1 Flush each system after completion by allowing full flow of water through the system for a period of fifteen minutes or longer when directed by the Consultant.
- .2 After flushing of the system is completed, provide a 24 hour contact sterilization treatment by treating the water with 50 ppm of chlorine as recommended in AWWA Specification C-651. After sterilization period has elapsed, flush system to reduce chlorine content to an acceptable level.

3.11 Pressure Tests

- .1 Make specified pressure tests on all piping included in this Contract. Furnish all pumps, compressors, gauges and connectors necessary for the tests.
- .2 Conduct tests in the presence of the Consultant and all other personnel of governing authorities having jurisdiction. Notify all parties in ample time to permit them to be present. Conduct tests before piping is painted, covered or concealed.
- .3 Conduct hydrostatic tests for a minimum period of 2 hours, or longer when requested by the Consultant or governing authority at the test pressure specified under the respective Section of the Specifications
- .4 During this time the pressure shall remain constant and the exterior surfaces of pipe or fittings shall not show any cracks or other form of leak.
- .5 For pneumatic tests, first pressurize the system with air to approximately one-half the specified pressure but not to exceed 345 kPa (50 psig) and examine all joints for leaks with a soapsuds solution. After any repairs have been made and the soap test has been met satisfactorily, pressure the system with air to the test pressure specified under the respective Section of the Specifications.
- .6 Conduct final tests on natural or propane gas piping in accordance with the requirements of the local Utility or governing authority. If feasible, make tests when ambient air temperature is approximately constant. Take into account corrections for pressure change due to temperature differential as approved by the Consultant.
- .7 Disconnect pumps or compressors used for applying the test pressure, during the test period.

Mechanical General Requirements

- .8 Disconnect and/or remove equipment or specialties not designed to withstand the test pressure during the test and reconnect same after completion of test.
- .9 Promptly correct any defects that develop through tests and re-test to the complete satisfaction of the Consultant and other parties involved.
- .10 Forward copies of all final tests on all pressure and drainage piping and a copy of governing authority approvals to the Consultant immediately on acceptance of tests and/or approvals. Forward copies of test reports to Consultant and Commissioning Authority.
- .11 Final payment for the work will not be made until the above has been received.

3.12 Performance Testing And Balancing

- .1 Assume responsibility for testing, balancing and placing all air handling and liquid systems in operation, prior to final acceptance in presence and under direction of Engineer. See Section 23 05 93 Testing, Adjusting and Balancing for HVAC.
- .2 Standard test sheets are appended to this Section. Fill out applicable sheets during performance tests, start-up procedures, and commissioning procedures. Submit 3 copies to Engineer prior to acceptance.
- .3 Provide all instruments required to test and balance systems. Install test probe inlets in ductwork and equipment in locations selected by the Engineer. Balance systems in accordance with design requirements indicated on the Drawings. Report to the Engineer immediately any deficiencies in the systems or equipment performance resulting in design requirements being unobtainable.
- .4 On completion of testing and balancing of all systems, submit to Engineer a typewritten report (4 copies) of findings, including complete data of fan performance, static pressures, air quantities, final readings at all outlets, and ampere readings of all motors, taken at motor terminals when equipment is operating under full load conditions. Send copies of TAB Report to the Commissioning Authority to review.
- .5 Submit with each copy of the report, complete sets of duct layout prints neatly marked in red ink, showing all locations at which test readings were taken, the air volume, velocity and static pressure in each supply and return duct, and the final reading at all outlets. Obtain duct layout prints for mark-up purposes from the Engineer.

3.13 Cleaning, Testing and Approval Records

- .1 Maintain records of all pressure tests and flushing and sterilization tests, glycol/water concentrations, inspections and approvals by the Plumbing Inspector, etc. and forward these to the Minister on completion of the work. Provide Engineer and Commissioning Authority with copy of records on completion of each test, cleaning operation, etc.

Mechanical General Requirements

3.14 Adjustment and Operation Of Systems

- .1 When the work is complete, adjust all equipment items of the various systems for proper operation within the framework of design intent, and the operating characteristics as published by the equipment manufacturer.
- .2 Note: Additional instructions are specified under the respective Sections of this Division.
- .3 The Engineer reserves the right to require the services of an authorized representative of the manufacturer in the event that any item of equipment is not adjusted properly. Arrange for such services and bear all incurred costs thereof. After completion of adjustments, place the systems in full operating condition and advise the Engineer that the work is ready for acceptance.

3.15 Commissioning

- .1 The General Contractor through the Mechanical Contractor shall carry in his tender the cost for all performance testing of equipment and systems in accordance with the Commissioning Authority requirements and requirements of the project specification and manufacturer's recommendations. Commissioning shall be performed by a third party consultant.

3.16 Acceptance

- .1 After all equipment has been installed and adjusted and all systems balanced, conduct performance tests in the presence of the Engineer. Arrange the time for these tests at the convenience of the Engineer. Conduct tests under climatic circumstances to ensure complete and comprehensive tests and of such a manner and duration as the Engineer may deem necessary.
- .2 During these tests, demonstrate the correct performance of all equipment items and of the systems they comprise. Should any system or any equipment item fail to function as required, make such changes, adjustments or replacements necessary to meet the performance requirements. Repeat tests until these requirements have been fully satisfied and all systems accepted by Engineer.

END OF SECTION

Fire Sprinkler System

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.
- .3 The sprinkler system for this project is a "Design Built" system.

1.2 Summary

- .1 Section Includes
 - .1 Labour, products, equipment, and services necessary to complete the work of this Section.
 - .2 Section includes, but is not necessarily limited to, the following:
 - .1 Design of automatic sprinkler systems in compliance with OBC and NFPA 13.
 - .2 Preparation of working drawings and getting all approvals before proceeding with work.
 - .3 Incorporation of facilities and equipment in an overall fire protection system.
 - .4 Connection to buried fire mains 1.5 m outside building wall and buried leads into building and to above floor line including thrust blocks at buried elbows.
 - .5 Fire Department connections.
 - .6 Wet pipe sprinkler system and dry pipe sprinkler system(s) for unheated areas.
 - .7 Excavating, bedding, and backfilling of pipe trenches for buried piping installed under this Section.
 - .8 Supervisory switches on riser valves and other isolating valves, water flow switches and pressure switches on alarm valves and risers.
 - .9 Electrical wiring as noted.

1.3 Related Sections

- .1 Section 01 33 00: Submittal Procedure
- .2 Section 01 40 00: Quality Requirement
- .3 Section 01 41 00: Regulatory Requirement
- .4 Section 01 78 39: Record Document

Fire Sprinkler System

1.4 Reference Standards

- .1 Comply with the latest edition of the following:
 - .1 National Fire Protection Association
 - .1 NFPA 13 Installation of Sprinkler Systems
 - .2 Ontario Building Code

1.5 Design Criteria

- .1 Design Submissions
 - .1 Prepare complete drawings of fire protection using sprinkler specification and drawings as a minimum criteria. Drawings shall be prepared in accordance with Architectural Detail Drawings, showing bulkheads, ceiling pockets, obstructions, floor openings, open suspended ceilings and combustible/non-combustible spaces. The Sprinkler Drawings DO NOT show these details. Obtain all information from Architectural Detail Drawings.:
 - .1 Drawings and calculations bearing stamp of a Professional Engineer employed by the Fire Protection Company and who is registered as a member of the Association of Professional Engineers of the Province of Ontario.
 - .2 Submit reviewed shop drawings to local municipal authority and obtain their approval before proceeding with any work. Pay all cost for obtaining their approvals.
 - .3 Submit four (4) copies of approved plans, hydraulic design calculation sheets, shop drawings and equipment submittals to Architect for review prior to commencement or work.
 - .4 Provide systems in accordance with approved drawings, subject to inspection and testing requirements of Owner's Insurance Underwriter and Consultant.
 - .5 Revise drawings incorporating all comments and submit eight (8) copies to all concerned trades.
 - .6 Sprinkler System shall be design to meet requirements of Ontario Building Code, NFPA-13 and local Fire Department including required sprinkler density per square foot.
- .2 Water Flow Test Data
 - .1 Perform water flow test and use as basis of hydraulic calculations.

1.6 Submittals

- .1 Shop Drawings
 - .1 Submit shop drawings in accordance with Section 013300.

Fire Sprinkler System

.2 Samples

.1 Submit samples for the following:

- .1 Each type of sprinkler.
- .2 Signs.

.3 Operation and Maintenance Data

.1 Submit printed operating instructions and maintenance data in accordance with Section 01 78 23.

.4 Maintenance Materials

.1 Provide the following materials at project handover:

- .1 Storage cabinet
- .2 Sprinkler wrench
- .3 Spare stock of eight sprinklers of each type. Include at least one head of temperature rating installed in system.

1.7 Quality Assurance

.1 Qualifications

- .1 An accredited member in good standing of the Canadian Automatic Sprinkler Association.
- .2 Has done five (5) similar projects.

1.8 Codes And Regulations, Permits, Costs and Fees

- .1 Comply with Municipal or Provincial Codes, Rules and Regulations and/or Authorities having jurisdiction.
- .2 Apply for and obtain permits required for this work and pay costs levied for permits, inspections and fees for getting all approvals.
- .3 Comply with the Building Code and NFPA-13.
- .4 Revisions issue: latest version as amended to date.

PART 2 - PRODUCTS

2.1 General

- .1 Unless otherwise noted, equipment and apparatus to be ULC listed and labelled, and FM approved.

2.2 Sprinkler Heads

.1 Ratings

- .1 ULC and FM listed for fire service.

Fire Sprinkler System

- .2 Standard orifice size: 12 mm diameter orifice or 13 mm diameter orifice recessed bulb type with coverplate.
- .3 Standard temperature rating: 57°C to 74°C.
- .4 Intermediate and high temperature rating heads to suit local conditions.
- .5 Side Wall
 - 2 .1 Bulb type semi-recessed with escutcheon.”
- .2 Type
 - .1 Indicated by type in accordance with the following:
 - .2 No ceilings
 - .1 Upright, bronze body, bulb type
 - .3 Hard ceilings
 - .1 Semi recessed, chrome plated body ring and cup, glass bulb type with matching colour plate to match ceiling. For dry system, sprinkler shall be suitable for dry pendant type.
 - .4 T-bar ceilings
 - 3 .1 Semi recessed with escutcheon and coverplate to match ceiling.
 - .5 Side wall
 - .1 Side wall, chrome plated body and escutcheon plate, bulb type
 - .6 Spare heads and cabinet
 - .1 Each sprinkler system: ULC approved metal cabinet containing required number of spare sprinkler heads of each type and temperature rating.
 - .2 Wrench for removal and replacement of sprinkler heads.
 - .7 Dry Sprinkler Head
 - .1 Sprinkler for dry pipe system shall be suitable of dry pendent or dry upright system.
 - .2 All entrance vestibules shall have semi recessed dry pendent sprinkler heads.
 - .8 Acceptable Manufacturers
 - .1 Viking Sprinkler Company
 - .2 Tyco Fire
 - .3 Approved Alternate

2.3 Alarm Check Valves (Wet and Dry Pipe System)

- .1 General
 - .1 ULC and FM listed for fire service

Fire Sprinkler System

- .2 Of same manufacture as specified for sprinkler heads
- .2 Wet and Dry Sprinkler Systems
 - .1 Construction
 - .1 Fitted with OS & Y gate valves
 - .2 Flow and pressure switches
 - .3 Low pressure switches
 - .4 Alarm piping connection to water motor gong
 - .5 Upstream and downstream pressure gauges
 - .6 Test connection
 - .7 Main drain valve
 - .8 Excess pressure pump / air compressor

2.4 Ancillary Equipment

- .1 Water Gong
 - .1 Water operated outside alarm bell, weather protected.
- .2 Excess Pressure Pump
 - .1 Construction
 - .1 Close coupled bronze pump with stainless steel shaft
 - .2 Motor size, pump size, and head.
 - .3 Pressure switch with pressure differential of 100 kPa to operate excess pressure pump c/w H/O/A starter.
 - .4 Shut-off valve and strainer on pump inlet.
 - .5 Relief valve, check valve and shut-off valve on pump discharge connection.
- .3 Air Compressor
 - 4 .1 Minimum 1/3 H.P.
 - 5 .2 H/O/A starter
 - 6 .3 Pipes to dry pipe system
- .4 Double Check Valves and Backflow Preventers
 - .1 Construction
 - .1 ULC and FM listed for fire service.
 - .2 Backflow preventer assemblies to be in accordance with CSA Standard B64.4-1976.

Fire Sprinkler System

.2 Acceptable Manufacturers

- .1 Wilkins
- .2 Watts
- .3 Approved Alternate

2.5 Pipe & Fittings

- .1 Provide new pipe and fittings free from rust and scale of full weight, standard size and thickness, true and round with full cut threads. Cut pipes true with clean sharp pipe cutters. Ream and file ends of pipe and remove burrs from interior. Use reducing fittings instead of bushings wherever reductions in piping occur.
- .2 Unburied mains and sprinkler piping: standard black steel Schedule #40 (ASTM #A53) with black cast iron 1207 kPa WWP screwed or flanged fittings, U.L.C. approved. Victaulic or Couplox couplings and fittings with Butyl gaskets conforming to CSA #B242 may be used where approved by Insurance Underwriter and local authority.
- .3 Where approved by Consultant and local authority and Underwriter, Schedule 10 pipe and factory fabricated welded assemblies using ANSI #B16.9 factory made fittings may be used. DO NOT THREAD SCHEDULE 10 PIPE.

PART 3 - EXECUTION

3.1 General

- .1 Apportionment of the Work
 - .1 Classify and apportion all materials and the performance of all labour to trades involved in accordance with all local customs, rules, regulations, jurisdictional awards, decisions, etc., insofar as they may apply and as required to efficiently execute the work involved in this Contract.
- .2 Measurements and Deviations
 - .1 Examine work of other Trades or Contractors and existing conditions at building prior to commencement of fire protection installations. Immediately report in writing to Consultant any discrepancies on the part of any other Contractor which will affect fire protection installations. Failure to report discrepancies shall be considered acceptance of conditions.
 - .2 Where site conditions require deviations from indicated arrangements on shop drawings or locations, make changes on approval of Architect without additional cost to Owner.
 - .3 Should discrepancies occur during installation of fire protection work which will necessitate major revisions, immediately notify Architect and secure his authorization in writing before proceeding with the work.

Fire Sprinkler System

3.2 Installation

.1 Sprinkler Heads

- .1 In T-bar ceilings, locate heads in centre of ceiling tile to present an orderly appearance.

.2 Systems

- .1 Provide for each sprinkler system riser with an alarm check valve assembly with all trims.
- .2 Extend drain piping from main drain valve through building wall and terminate with standard hose nipple to funnel floor drain.
- .3 Provide an excess pressure pump and air compressor to maintain excess pressure on downstream side of alarm check valve. Provide piping connections to each riser, and controls for automatic and manual operation of pump and air compressor.
- .4 Mount a water motor gong on exterior surface of building wall, where noted, complete with water piping connections to alarm check valve(s). Provide drain piping to a point 150 mm above grade.
- .5 Electrical Division will provide power to the excess pressure pump and air compressor. Electrical connections from pressure switches, flow/monitoring, low pressure switch and monitoring switch to fire alarm system is by Electrical Division.
- .6 Equip each riser with pressure and flow switches with the following functions:
 - .1 To start and stop excess pressure pump and air compressor with H/O/A starter.
 - .2 Supervisory system central station alarm
 - .3 Interior alarm bell
- .7 Provide sprinkler cage to each sprinkler head located outside of building and in storage rooms, located outside of building and other areas subject to damage on normal use.
- .8 Obtain Architect's approval on site for all exposed pipes before proceeding with work.
- .9 Connect new 150 mm sprinkler main to 150 mm water service at 1500 mm outside of building provided by Another Section and extend to building sprinkler system. Perform all required excavation and backfill.

.3 Backflow Preventers

- .1 Isolate automatic sprinkler system to comply with the Ontario Building Code and local authorities.
- .2 In addition to the requirements under the Ontario Building Code, provide listed backflow valve assemblies as shown or as required by the authorities having jurisdiction. Test each unit on site and submit test certificates.

Fire Sprinkler System

.4 Test Connections and Drains

- .1 Locate inspector's test connections, complete with valve, sight glass, and drain piping either at high points of sprinkler system or at the end of the longest run of sprinkler piping in accordance with NFPA 13.
- .2 Test each backflow preventer on site and submit test results.

.5 Flushing of Piping

- .1 Flush sprinkler system piping in accordance with NFPA requirements and local Authorities.
- .2 Flush underground piping and lead-in connections before connection is made to sprinkler system risers and local Authorities.

3.3 Piping

.1 General

- .1 Hang or support piping with miscellaneous structural supports and braces as may be required, unless Drawings or other Sections of the Specifications state otherwise.

.2 Materials and Fabrication

- .1 Conform to CAN/CSA-S16.1M for materials, design of details and execution of the work.
- .2 Conform to CAN/CSA-G40.21-M grade 300W for structural shapes, plates, etc.
- .3 Conform to the latest issue of the following CSA Specifications.
 - .1 CSA W47.1 - for qualification of welders
 - .2 CSA W48.1-M - for electrodes (only coated rods allowed)
 - .3 CSA W59-M - for design of connections and workmanship
 - .4 CAN/CSA W117.2-M - for safety

- .3 Obtain Architect's approval on site before installation of all exposed pipes.

3.4 Testing

.1 Requirements

- .1 Execute fire protection systems and equipment tests in accordance with NFPA requirements.
- .2 Minimum hydrostatic test of not less than 1380 kPa pressure for two hours, or at 345 kPa in excess of maximum static pressure developed in system, if maximum static pressure is in excess of 1034 kPa.
- .3 Furnish pumps, gauges and other equipment required to complete test.
- .4 Execute tests in presence of Consultant and Owner's authorized representative.

Fire Sprinkler System

- .5 Promptly repair defects which develop during tests, and then re-test system to complete satisfaction of authorized inspectors.
- .6 Submit a certificate covering materials and tests to Underwriter's Inspection Authority, together with a request for inspection and approval of complete fire protection system. On receipt of approval, forward certificate to Owner.
- .7 Perform all tests required by local Authorities and obtain their approvals.

3.5 Special Instructions

- .1 Obtain Architect's approval on site for all exposed pipes prior to installation.

END OF SECTION

Fire Extinguisher and Safety Blankets

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 References

- .1 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S508-M90(R1995), Rating and Fire Testing of Fire Extinguishers and Class "D" Extinguishing Media.

1.3 Shop drawings and Product Data

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.

1.4 Closeout Submittals

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

PART 2 - PRODUCTS

2.1 Multi-Purpose Dry Chemical Extinguishers (FE)

- .1 Cartridge operated type or Stored pressure rechargeable type with hose and shut-off nozzle, ULC labelled for A, B and C class protection. Sizes 3A-10BC.

2.2 Ordinary Dry Chemical Extinguishers - Kitchen

- .1 ULC labelled for B and C class protection. Sizes 2OBC.

2.3 Cabinets (CAB)

- .1 Fully recessed type constructed of 1.6 mm thick stainless steel, 180o opening door of 2.5 mm thick steel with latching device.
- .2 Cabinet to maintain fire resistive rating of construction in which they occur.
- .3 Cabinet door: with 5 mm full glass panel stainless steel panel.
- .4 Finish:
 - .1 Tub: prime coated.
 - .2 Door and frame: No.4 stainless steel.

Fire Extinguisher and Safety Blankets

- .5 Provide one multi purpose 3A-10BC in each cabinet.

2.4 Identification

- .1 Identify extinguishers in accordance with recommendations of ANSI/NFPA 10 CAN/ULC-S508.
- .2 Attach tag or label to extinguishers, indicating month and year of installation. Provide space for service dates.

PART 3 - EXECUTION

3.1 Installation

- .1 Install or mount extinguishers in cabinets or on brackets as indicated.
- .2 Install each unit at height to suit Fire Code.
- .3 Provide five (5) additional 3A-10BC extinguishers and install at location as later directed on site.

END OF SECTION

Thermal Insulation for Piping

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to General Mechanical Requirements Section 23 05 00 as applicable.

1.2 Related Sections

- .1 Finish painting of insulated work: Section 09 91 10 Interior Painting.

1.3 Submittals

- .1 Shop Drawings: Before ordering any insulating materials, submit to the Consultant a list of proposed insulation materials, exterior jackets and adhesive for the various services and equipment on the project. Deviation from the approved list will not be allowed.
- .2 Samples: Before ordering any insulation materials, prepare a sample board with a cross-section sample of all types of insulation, including exterior jacket, properly identified for the various services and equipment on the project and state types of adhesives used. Submit the sample board to the for his review and, after review and acceptance, the sample board will be kept in the 's site office for the duration of the project for reference. Deviation from the accepted samples will not be allowed.

PART 2 - PRODUCTS

2.1 Plumbing Pipes

- .1 Unburied domestic cold water piping: 25 mm thick heavy density glass fibre preformed pipe insulation with maximum of 0.033 conductivity at 10oC mean with factory applied vinyl foil kraft laminated glass fibre reinforced fire resistive vapour barrier jacket with not more than 1.15 perm rating (ASJ) with sealed lapped joints. Insulate heat pump condensate lines similarly.
- .2 Unburied domestic recirculation and hot water piping: heavy density glass fibre preformed pipe insulation with maximum 0.043 conductivity at 93oC mean. Use 25 mm thickness on piping up to 50 mm size, and 38 mm thickness on piping 63 mm and above.
- .3 On water and waste piping and trap below each Handicapped lavatory: insulate with 13 mm Armaflex II or Acwil "Therma-Cel" flexible foamed elastomeric insulation. Paint insulation with two coats of "White Finish".
- .4 Unburied Rainwater Leaders and storm drains both exposed and concealed: insulate with 25 mm thick fiberglass pipe covering with factory applied aluminum fire resistant vapour barrier and sealed lapped joints. Insulate underside of roof hoppers.

Thermal Insulation for Piping

- .5 Sanitary drains: insulate as for storm drains above. Also insulate horizontal wastes from urinals, toilets and drinking fountains to vertical stack.
- .6 Exterior exposed piping: weatherproof insulation with two coats of Flintkote #C-29 applied over 45# building paper copper wired on and sealed to approval. Install insulation after electric trace wiring is tested and approved, if tracing is specified.
- .7 Insulate each hot water circulating pump with 16 gauge thick galvanized sheet metal, horizontally split enclosure lined with 38 mm thick Styrofoam SM insulation secured with adhesive and welding clips and pins with bolted and gasketed angle flange connection.
- .8 Insulate (50mm thickness) all electrically traced pipes including pipe drops.
- .9 Pipe insulation exposed to weather with 50 mm thick rigid glasswool 72 kg/m³ density vapour-seal insulation. Seal holes with Bakelite #110-14. Butt joints firmly together and tape with 75 mm wide 10 x 20 weave Glasfab secured by #110-14. Apply coating of #110-14 over entire surface. Apply layer of 10 x 20 weave Glasfab followed by second coat of #110-14 over entire surface. Apply #110-14 at not less than 10 litres per 8.18 m² of area. Raise top surfaces of insulation and weatherproofing in centre to shed water to sides. After completion provide PVC jacketing.

PART 3 - EXECUTION

3.1 General

- .1 Perform insulation work using qualified insulation applicators, in accordance with latest trade application methods and to the Consultant approval.
- .2 Clean all surfaces to be insulated to remove grime, grease, oil, moisture or other matter to ensure that insulation is applied to clean dry surfaces.
- .3 Apply insulation under ambient temperature conditions in accordance with insulation or adhesive manufacturer's recommendations.
- .4 Do not apply insulation until piping and heat tracing, has been tested, inspected, verified, and accepted.
- .5 Apply insulation neatly and tightly in unbroken lengths and with ends of sections firmly and squarely butted or engaged together. Lap canvas or other specified wrapping over all joints and thoroughly cement down with adhesive. Extend insulation through sleeves in walls (except fire walls) or other openings in building to make insulation and vapour barrier continuous and of uniform diameter.
- .6 Terminate insulation at each side of fire walls and pack the space between wall sleeve and pipe.
- .7 At expansion joints in piping, apply insulation over a sleeve of 1.6 mm (16 gauge) metal, fabricated to fit around expansion joint without restricting its movement. Fabricate sleeve so it can be removed to allow for the repacking and lubrication of expansion joint without damaging the adjoining insulation. Extend sleeves a minimum of 75 mm (3") longer than expansion joint, fit with insulation retaining flanges and with a means of maintaining the position of sleeve over expansion joint.

Thermal Insulation for Piping

- .8 Where piping is specified to be heat traced, provide oversized insulation to accommodate tracing cable specified in Electrical Specifications.

3.2 Insulation Protection Bearing Plates

- .1 Remove temporary spacers and install a section of asbestos-free calcium silicate insulation extending at least 150 mm (6") beyond each end of the bearing plate.
- .2 Bond insulation to the bearing plate with Foster 85-20 or Bakor 230-39 or polymer waterproof adhesive and finish and seal the complete assembly with Foster 60-38 or Bakor 130-11 or polymer to form an unbroken vapour barrier.
- .3 Reinstall or readjust any hanger or support which has been moved in any way to carry out the above work.

3.3 Plumbing Pipe Insulation

- .1 Insulate flanges, valves, and fittings with segments of insulation of the same type and thickness as the insulation on the pipe, secured in place with soft annealed galvanized wire. Finish with Partek Hilcote insulating and finishing cement, and cotton wrapping applied while the cement is still wet.
- .2 Apply 75 mm (3") wide butt strips of the same material as the factory applied jacket. Seal both longitudinal and butt joint strips with Foster 85-20 or Bakor 230-39 or polymer vapour barrier fire resistive lap sealer, or secure with self seal lap joints where provided.
- .3 Insulate fittings, flanges and valves with fibrous glass insulation of same thickness as adjoining pipe insulation and finish with a pre-moulded PVC cover, securely fastened and sealed to adjoining pipe covering with Foster 85-75 or Bakor 230-39 or polymer to form a vapour proof joint.
- .4 Do not insulate screwed unions and final connections to fixture.
- .5 Terminate insulation at each end of unions with Partek Hilcote insulating and finishing cement, trowelled on bevel.
- .6 Build up insulation at joints and fittings with two or more layers of insulation to form an unbroken surface over joint, coupling or fitting.

3.4 Surface Finishes

- .1 Cover exposed insulated piping, valves and fittings in Boiler Rooms, Mechanical Rooms, Equipment Rooms, and areas where vehicular traffic, etc. could damage the insulation, with 220 g/m² (6 oz.) canvas.
- .2 Do not apply canvas to elastomeric closed cell foam or neoprene insulation, and piping which will be concealed or furred in.

Thermal Insulation for Piping

- .3 Securely paste canvas on with a two coat application of Foster 30-36 or Bakor 120-18 fire resistive lagging adhesive over the entire surface. Apply canvas between coats of adhesive, while first coat is still wet. Stretch canvas tight and smooth with overlapping seams located where least visible. Apply second coat of adhesive immediately following application of canvas. Do not use metal bands.
- .4 Finish piping, valves and fittings indoors and outdoors insulated with elastomeric closed cell foam or neoprene with a full coating of white acrylic latex as recommended by insulation manufacturer.
- .5 Finish all other insulated piping installed outdoors with a field or factory applied metal jacket of 0.4 mm (26 ga.) aluminum, with longitudinal "snap-lock" or lapped joints and caulked and strapped butt joints secured with sheetmetal screws. Alternatively, finish pipe and fittings with glass fabric and Foster 65-07 or Bakor 110-26 or polymer fire resistive mastic as previously specified. Locate longitudinal joints in the bottom sector of horizontal lines and with laps positioned to shed any moisture.
- .6 On single ply roofs extreme care must be taken when applying mastic sealers to piping to ensure that no surplus mastic material remains in contact with the roof membrane. Any accidental spills must be cleaned up immediately. Provide temporary plastic drop sheets to protect roof around work area. Remove drop sheets on completion and clean-up of insulation work.
- .7 Seal canvas with off-white sizing to leave a smooth non-porous surface ready to receive paint application.
- .8 Finish exposed insulated piping within 2.4 m of finished floor level of clean process areas with an exterior metal jacket of 0.4 mm (26 ga.) aluminum, with longitudinal "snap-lock" joints and strapped butt joints. Conceal longitudinal joints from view. The metal jacket may be field, or factory applied.

END OF SECTION

Pumps

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Summary

- .1 Section Includes
 - .1 Labour, products, equipment and services necessary to complete the work of this Section.

1.3 Submittals

- .1 Shop Drawings
 - .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Operation and Maintenance Data
 - .1 Submit printed operation instructions and maintenance data in accordance with Section 01 78 23.

PART 2 - PRODUCTS

2.1 Pumps - General Requirements

- .1 The following are minimum construction requirements, unless specified elsewhere.
- .2 Pump Casings
 - .1 Close grained cast iron or cast bronze as specified.
 - .2 Fitted with casing or impeller wear rings, or both.
- .3 Impellers
 - .1 Enclosed bronze or duralloy.
 - .2 Dynamically balanced.
 - .3 Mounted on carbon steel shaft fitted with stainless steel or bronze sleeves.
- .4 Seals
 - .1 Suction pressures less than 640 kPa: fitted with mechanical seals.
 - .2 Stuffing box pressure in excess of 690 kPa: balanced type seals.
 - .3 Pumps with packing glands: fitted with stainless steel shaft sleeves for full length of stuffing box.

Pumps

.5 Performance

- .1 Characteristic curve to be continuously rising from run-out to shut-off.
- .2 Select pump to operate within flow range from 30% below point of maximum efficiency to 10% above that point for impeller diameter chosen.
- .3 Installed impeller diameter not to exceed 90% of maximum impeller diameter catalogued for pump casing.
- .4 Motors to be sized for continuous operation without motor overload at runout condition for impeller size and rotational speed selected.

2.2 Domestic Water Pumps - In Line Cirulators

.1 Construction

- .1 Capacity: .315 L/s (5 gpm) 2.4 meters (8 ft.), 124 watts, 120 V, single phase
- .2 Working pressure: to 1200 kPa
- .3 Bronze construction with alloy steel shaft.
- .4 Shaft with integral thrust collar, mechanical seal, supported by two oil lubricated bronze sleeve bearings.
- .5 Resiliently mounted motor.

.2 Manufacturers

- .1 S. A. Armstrong Limited
- .2 ITT Fluid Products Canada (Bell & Gossett)
- .3 Taco
- .4 Approved Alternate

PART 3 - EXECUTION

3.1 INSTALLATION

.1 General

- .1 Set in place, and make piping and electrical connections to pumps in accordance with manufacturer's instructions.
- .2 Check pump rotation.
- .3 Set up and adjust controls.
- .4 Pipe drain tapping to drain.
- .5 Install gauges at suction and discharge.
- .6 Install shutoff valve and pressure gauge above floor.
- .7 Provide all wiring to complete the system and make operational.

Pumps

.2 In-line Circulators

- .1 Install with fluid flow direction as indicated by flow arrows on pump body.
- .2 Support piping and pump at flanges or near unions on connections to unit.
- .3 Install with bearing lubrication points accessible.
- .4 Check pump rotation.

END OF SECTION

Domestic Piping

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 References

- .1 ANSI B16.18-[1984], Cast Copper Alloy Lead Free Solder Joint Pressure Fittings.
- .2 ASTM B88M-[89], Specification for Seamless Copper Water Tube (Metric).
- .3 MSS-SP-80-[1987], Bronze Gate, Globe, Angle and Check Valves.

1.3 Product Data

- .1 Submit product data in accordance with Section 013330.
- .2 Submit data for valves.

1.4 Maintenance Data

- .1 Provide maintenance data for incorporation into manual specified in Section 01770 - Operation and Maintenance Manual.

PART 2 - PRODUCTS

2.1 Piping

- .1 Domestic hot, cold and recirc systems, within building.
- .2 Above ground: copper tube, hard drawn, type L: to ASTM B88M.
- .3 Buried or embedded: copper tube, soft annealed, type K: to ASTM B88M, in long lengths and with no buried joints.

2.2 Fittings

- .1 Cast bronze threaded fittings, Class 125 and 250: to ANSI/ASME B16.15.
- .2 Cast copper, solder type: to ANSI B16.18.

Domestic Piping

2.3 Joints

- .1 Solder/brazing: lead free silver solder.
- .2 Teflon tape: for threaded joints.

2.4 Gate Valves

- .1 NPS 2 and under, screwed:
 - .1 Rising stem: to MSS SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc.
 - .2 Acceptable material: Crane, Toyo, Red & White, or Approved Alternate

2.5 Globe Valves

- .1 NPS 2 and under, soldered:
- .2 To MSS SP-80, Class 125, 860 kPa, bronze body, renewable composition disc, screwed over bonnet.
 - .1 Lockshield handles: as indicated.
 - .2 Acceptable material: Crane, Toyo, Red & White or Approved Alternate

2.6 Swing Check Valves

- .1 NPS 2 and under, soldered:
- .2 To MSS SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat.
- .3 Acceptable material: Crane, Toyo, Red & White or Approved Alternate

2.7 Ball Valves

- .1 NPS 2 and under, soldered:
 - .1 To ANSI B16.18, Class 150.
 - .2 Bronze body, chrome plated brass ball, PTFE Teflon adjustable packing, brass gland and [PTFE Teflon] seat, steel lever handle, with NPT to copper adaptors.
 - .3 Acceptable material: Crane, Toyo, Red & White or Approved Alternate

Domestic Piping

2.8 Circuit Balancing Valve

- .1 Tour & Anderson Model 786 complete with check and shutoff valve.

PART 3 - EXECUTION

3.1 Installation

- .1 Install in accordance with Building Code local authority having jurisdiction and Manufacturer's requirements.
- .2 Cut square, ream and clean tubing and tube ends, clean recesses of fittings and assemble without binding.
- .3 Assemble all piping using fittings manufactured to ANSI standards. Connect water line to existing main serving existing building.
- .4 Install tubing close to building structure to minimize furring, conserve headroom and space. Group exposed piping and run parallel to walls.
- .5 Connect to fixtures and equipment in accordance with manufacturer's instructions unless otherwise indicated.
- .6 Buried tubing:
 - .1 Lay in well compacted washed sand in accordance with AWWA Class B bedding.
 - .2 Bend tubing without crimping or constriction. Minimize use of fittings.
 - .3 Provide all required excavation and backfill.

3.2 Valves

- .1 Support all overhung pipes to approval.
- .2 Isolate equipment, fixtures and branches with ball valves.
- .3 Balance recirculation system using circuit balancing valves. Mark settings and record on as-built drawings on completion.

3.3 Disinfection

- .1 Flush out, disinfect, rinse, and chlorinate system to requirements of authority having jurisdiction approval of Consultant and Local Plumbing Inspector. Provide laboratory test reports on water quality for Consultant approval.

Domestic Piping

3.4 Tests

- .1 Test all pipes and joints in accordance with Ontario Building Code - Plumbing Code and to local Authority requirements.
- .2 Pressure test buried system before backfilling.

END OF SECTION

Drainage Waste and Vent Piping

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Summary

- .1 Section Includes:
 - .1 The installation of drainage waste and vent piping.
 - .2 Sustainable requirements for construction and verification.

1.3 References

- .1 Canadian Standards Association (CSA International).
 - .1 CSA B67, Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.
 - .2 CAN/CSA-B70, Cast Iron Soil Pipe, Fittings and Means of Joining.
 - .3 CAN/CSA-B125, Plumbing Fittings.

PART 2 - PRODUCTS

2.1 Material

- .1 Sustainable Requirements:
 - .1 Materials and resources in accordance with Section Sustainable Requirements.

2.2 Pipes

- .1 Buried:
 - .1 Buried pipe: cast iron ferrule with inside caulked or spigot connection outlet, seal plug and nickel brass frame and cover suitable for type of floor in which it is to be installed, e.g. tile, terrazzo, carpet, concrete, etc. Provide membrane clamp if installed on membrane floors.
 - .2 Buried interior drains can be laid on approved solid bedding and shall be D.W.V. plastic P.V.C. solvent weld gravity sewer solvent weld pipe (CSA #B182.1) SDR-28 to 150 mm size and SDR-35 for larger sizes, including all interior drainage piping for wall hung urinals. Use same pipe for wall hung urinals.
- .2 Above Ground Piping
 - .1 Cast iron piping in exposed location or in accessible pipe chases: cast iron body with straight threaded, coated plug having a tapered shoulder that seats against a lead seal.

Drainage Waste and Vent Piping

- .2 Copper stack piping in exposed locations or in accessible pipe chases: Bronze, cleanout tee, bronze ferrule, and cover, secured to ferrule by bronze cap screws.
- .3 Access cover for cleanouts concealed in walls: type to suit wall surface and construction.
- .4 Cover for cleanouts at base of vertical sanitary stacks or rainwater leaders: bolted type, neoprene gasket, and brass cap screws or bolt studs, unless shown otherwise on Drawings.

PART 3 - EXECUTION

3.1 Installation

- .1 Install in accordance with Ontario Plumbing Code and local authority having jurisdiction. Support all overhead pipes to approval. Provide vent line to each trap and pass thru roof.
- .2 Provide vent line to each fixture and trap to Building Code requirement.
- .3 Vent line thru their roof shall have very minimum penetrations and not less than 300 mm size.
- .4 Provide all excavation and backfill required for buried pipes.

3.2 Testing

- .1 Pressure test buried systems before backfilling.
- .2 Hydraulically test to verify grades and freedom from obstructions.
- .3 Test the system in accordance with the Ontario Building - Plumbing Code and to local Authority requirements.

3.3 Performance Verification

- .1 Cleanouts:
 - .1 Ensure accessible and that access doors are correctly located.
 - .2 Open, cover with linseed oil and re-seal.
 - .3 Verify that cleanout rods can probe as far as the next cleanout, at least.
- .2 Test to ensure traps are fully and permanently primed.
- .3 Ensure that fixtures are properly anchored, connected to system and effectively vented.
- .4 Affix applicable label (storm, sanitary, vent, pump discharge etc.) c/w directional arrows every floor or 4.5 m (whichever is less).

Drainage Waste and Vent Piping

3.4 Verification

- .1 Verification requirements in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification, include:
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.
 - .3 Construction waste management.
 - .4 Resource reuse.
 - .5 Local/regional materials.
 - .6 Low-emitting materials.

END OF SECTION

Facility Storm Drainage

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Summary

- .1 Section Includes
 - .1 Labour, products, equipments, and services necessary to complete the work of this Section.

1.3 Related Work

- .1 Section 07 55 63: Roofing System

1.4 Submittals

- .1 Shop Drawings
 - .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Operation and Maintenance Data
 - .1 Submit printed operation instructions and maintenance data in accordance with Section 01 78 23.

PART 2 - PRODUCTS

2.1 Drainage Specialties

- .1 Acceptable Manufacturers
 - .1 Zurn
 - .2 Watts
 - .3 J.R. Smith
 - .4 MI Fab
 - .5 Approved Alternate

Facility Storm Drainage

2.2 Roof Drains

- .1 Standard Roof Hoppers: Zurn #Z-121, Watts RD-100, Mifab R1200M-EUF, or J.R. Smith 2005A roof hoppers of sizes noted. Hopper shall have cast iron body, bottom or side outlet as required, multi-wier barrier with integral clamping device and gravel guard, large protected sump, waterproofing flange, 610 mm square bearing pan, underdeck clamp, clamping bolts, sediment bucket, extension frame and metal dome strainer. Dome shall have minimum free area of 594 cm².
- .2 Gutter Drain
Zurn (or approved equal) Z-181ZRB-BS-C cast iron with Bronze dome.

2.3 Pipes

- .1 Buried:
 - .1 Buried pipe: cast iron ferrule with inside caulked or spigot connection outlet, seal plug and nickel brass frame and cover suitable for type of floor in which it is to be installed, e.g. tile, terrazzo, carpet, concrete, etc. Provide membrane clamp if installed on membrane floors.
 - .2 Buried interior drains can be laid on approved solid bedding can also be D.W.V. plastic P.V.C. solvent weld gravity sewer solvent weld pipe (CSA #B182.1) SDR-28 to 150 mm size and SDR-35 for larger sizes, including all interior drainage piping for wall hung urinals.
- .2 Above Ground
 - .1 Cast iron piping in exposed location or in accessible pipe chases: cast iron body with straight threaded, coated plug having a tapered shoulder that seats against a lead seal.
 - .2 Copper stack piping in exposed locations or in accessible pipe chases: Bronze cleanout tee, bronze ferrule and cover, secured to ferrule by bronze cap screws.
 - .3 Access cover for cleanouts concealed in walls: type to suit wall surface and construction.
 - .4 Cover for cleanouts at base of vertical sanitary stacks or rainwater leaders: bolted type, neoprene gasket, and brass cap screws or bolt studs, unless shown otherwise on Drawings.

2.4 Miscellaneous Products

- .1 Back-Water Valves
 - .1 Cast iron body with gasketed cover, removable bronze valve disc and seat, and access cover. Sizes indicated on drawings.
 - .2 In finished areas, provide nickel bronze frame and round scoriated type cover. Sizes indicated on drawings.

Facility Storm Drainage

PART 3 - EXECUTION

3.1 Installation

- .1 Roof Drains
- .2 Verify roof construction. Each roof drain must be compatible type.
 - .1 Provide adaptors for connection to roof drain bodies.
- .3 Cleanouts
 - .1 Locate drainage cleanout fittings in drainage piping:
 - .1 At base of each vertical stack or rainwater leader
 - .2 As required to comply with applicable plumbing code.
 - .3 Verify that cleanout rods can probe as far as the next cleanout, at least.
- .4 Expansion Joints
 - .1 Provide vertical expansion joints near top of drainage pipe risers where total riser height exceeds 10 metres from ground level.
 - .2 Provide horizontal expansion joints on suspended drainage pipe which:
 - .1 Is welded
 - .2 Crosses a building expansion joint, whether the pipe is welded or not
- .5 Support all overhead pipes to approval.
- .6 Provide all excavation and backfill required for buried pipes.

3.2 Tests

- .1 Test all pipes and joints in accordance with Ontario Building Code - Plumbing Code and to local Authority requirements.
- .2 Pressure test buried system before backfilling.

END OF SECTION

Rainwater Retention System

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.
- .3 Provide Design Built operational rainwater harvesting system for lawn dripping irrigation. Submit working drawings for approval showing all components of system.
- .4 All equipment shall be supplied thru single source. Supplier must provide a complete operational system, review entire system requirement prior to installation, during installation and shall submit confirmation in writing system performance and validate warranty for satisfactory operation of system as provided by:
 - .1 NetZero Water – Tel.: 1-800-265-9355
 - .2 Engineered Solution – Tel.: 905-832-0909
 - .3 or Approved Equal

1.2 Summary

- .1 Section Includes
 - .1 Labour, products, equipment, and services necessary to complete an operational system the work of this Section.
 - .2 Prepared installation schematic diagram of proposed system and submit for review and approval

1.3 Related Work

- .1 Section 22 11 18: Domestic Water Supply
- .2 Section 22 13 20: Facility Storm Drainage
- .3 Section 01 33 00Submittal
- .4 Section 01 78 23: Operational Manuals
- .5 Section 01 78 39: Record Documents

PART 2 - PRODUCTS

2.1 Cistern Tank

- .1 Retention tank will be provided by Another Section. This Contractor to provide all piping to and from retention tank to Irrigation Supply System.

Rainwater Retention System

2.2 Storm Water Re Use System

- .1 Provide one (1) pumps, variable speed motor, 1.2 kW (1-1/2 HP) 208V/3 ph c/w insect screen. Pump shall provide minimum 1.14 L/s at 46 m (18 gpm @ 65 psi) head at point of connection of irrigation supply pipe inside building. Mount pumps vertical in manhole. Provide pneumatic tank sized for minimum of one minute pump run.
- .2 Provide pressure relief valve and pressure switch at discharge of pump.
- .3 Pump shall operate upon low pressure. The pump motor speed will vary to maintain set pressure (site adjustable) in the system. Upon reaching to set pressure setpoint, the VFD shall ramp down the speed maintaining the required pressure in the system. The pump upon running at its minimum speed for a preset time, the pump shall enter in a sleep mode. The VFD will remain in a sleep mode until the pressure in the system drops below the desired operating pressure setpoint. The VFD shall brought back the pump on line to maintain the pressure in the system upon increase in demand or reduction in system pressure and shall maintain required pressure. The variable frequency drive (VFD) shall be programmed with an acceleration and deceleration rate for starting and stopping respectively. In the event the minimum speed of the VFD is maintained for a preprogrammed time frame, the VFD will enter a sleep mode to maximize hydro savings.
- .4 Provide ASCO Model 210 solenoid valves with flow switch (BMS monitor). Solenoid valve No. 1 shall open to allow City water fill, level inside cistern reaches last low level and shall close when reaches at high level. All levels shall be site adjustable. Solenoid Valve #2 shall remain open during pump fail or lack of water in cistern. Both solenoid valves shall have H/O/A feature thru control panel. Both solenoid valves shall work have separate level controls.

2.3 Controls

- .1 General
 - .1 Control shall be achieved through the user of a relay based pump controller capable of achieving the following real time tasks:
 - .2 Control pump station operation
 - .3 Alarm detection and annunciation with silencing switches and lights.
 - .4 Safety interlocking
 - .5 Interfacing of Hand-Off-Auto selector switch to the logic
 - .6 Interfacing of the level controls and pressure transducer to the controller
 - .7 Interfacing of the solenoid valves to the relay logic
 - .8 Spare contacts for each function to monitor thru BMS
 - .9 Provide cycle counter in control panel.
- .2 System Operation and Control
 - .1 The pumping station consists of one Rainwater distribution pump, solenoid valves, floats, filters and alarm and required treatment.

Rainwater Retention System

- .2 In the manual (Hand) mode the Rainwater Reuse System pump will start and continue to run an operator adjustable speed until one of the following conditions occurs:
- Pump is turned off
 - Cistern low level
 - Pump is overload fault
- .3 Under automatic operation, the pumps shall stop and start in response to the input from the pressure transducer and the pump controller. The pressure transducer will send a 0-10VDC signal to the pump controller. The operation will be able to adjust the following on the door mounted pump controller:
- PI operation point
 - Sleep mode setting
 - Wake mode setting
 - Low pressure shutdown setting
 - Time delays

When the pressure in the system drops to the wake up level, the pump VFD will ramp up the speed to achieve the PI pressure point. The pump will continue to maintain the PI pressure point until the demand is satisfied. The pump will then ramp down to the minimum speed and after maintaining that speed for a preset time the pump will shut down. The VFD will continue to operate on the basis of pressure.

.4 Rainwater Reuse System Pump Interlocks

The following interlocks will disable Rainwater Reuse System pump operation:

- .1 Low level float must open during the pumping cycle. Once it closes the pump will stop and will not restart until the level rises. Provide separate floats to open the City Water solenoid to provide a secondary source of water. Provide Pentair WL series wide angle normally closed float to eliminate the possibility of rapid cycling.
- .2 The pump will be disabled if one of the following electrical conditions occur:
- Pump is in the OFF position
 - Pump VFD fault
 - Pump circuit breaker tripped
 - Each function shall indicate by red light
 - Low level in cistern

Rainwater Retention System

.5 Solenoid Interlocks

.1 The following interlocks will disable solenoid operation:

- .1 Water solenoid selector switch is selected to the CLOSE or OPEN position as indicated. The solenoid shall operate through H/O/A selector switch and shall close and open to selector switch setting. In Auto position it shall remain close till control sequence requires it to open and supply city water to cistern and to irrigation system.

.6 Alarms

The following alarm will be annunciated with light at the pump station:

- .1 Cistern low level
- .2 Cistern high level
- .3 Rainwater Reuse System pump overload fault
- .4 City water make-up solenoid valve open
- .5 Pressure difference at filter

This alarm will annunciate a door mounted light, dry contacts and an alarm buzzer with silencing switch mounted on the panel.

.7 Control Panel

- .1 The pump controller is to be housed in an industrial quality heavy gauge steel meeting EEMAC 1 requirements. The panel is to come complete with a hinged door to open one hundred and eighty degrees to allow for full inside access.
- .2 The control panel is to house all necessary equipment to operate the pumps, and valves including power supply, level controls and control feeds to and from each pump and valve.
- .3 The incoming voltage for the panel will be 208V/3/60.
- .4 The control panel shall control Storm Water Reuse System distribution pump and solenoid valves.
- .5 The panel is to be supplied by the pump manufacturer, who shall be responsible for co-ordination of all devices to ensure the system is complete and will operate satisfactorily.
- .6 That all components are CSA approved and that the panel carries a CSA approval. All electrical equipment, wiring, grounding, and testing for this project must meet the Electrical Safety Code including all appendices and bulletins issued by the Hydro Inspectors Department applicable to this project.
- .7 The controller for this system will be a SGWCV series sized for the horsepower and voltage of the pumps as supplied by Pentair Canada or approved equal.

Rainwater Retention System

.8 Water Meter

- .1 Provide three (3) water meters with pulse reader for monitoring through BMS system. Each meter shall provide usage and demand pattern.

2.4 **Pneumatic Tank**

- .1 Provide one (1) hydropneumatics tank sized to pump flow and required pressure.

2.5 **Treatment System**

- .1 Provide required treatment of Rainwater supply for drip irrigation system. Provide as a minimum high capacity SSTL filter housing with 5-micron cartridge filter.

PART 3 - EXECUTION

3.1 **Installation**

- .1 Prepare schematic diagram showing system being installed and submit for approval.
- .2 Manufacturer of each equipment shall confirm compatibility of with all other equipment supplied under this Subsection and shall supervise installation and also confirm in writing for proper operation of each equipment. Obtain all required approval before proceeding for each manufacturer.
- .3 All equipment shall be preassembled in factory on a skid with stainless steel piping.
- .4 Provide all required wiring to all equipments. Division 16 will wire to control panel only and will extend to pump.
- .5 Install pump inside cistern at manhole. Provide screen baffle at inlet of pump.
- .6 Provide concrete support blocks and/or steel supports for fire pump discharge piping to securely anchor the piping from movement due to forces generated in the water system.
- .7 Pipe up pump discharge line to mechanical room and to control panel. Also provide water make-up line to cistern. Pipe shall be copper pipe and if approved GOLD901 HDPE made to AWWA C901, CSA and NFPA-61 rated for 260 psi.
- .8 Provide required excavation and backfill and supports for all pipes and equipment to manufacturer direction.
- .9 Provide marking "Rainwater Reuse System –Non Potable" on supply pipes in accordance with OBC clause 7.7.2.1. Non potable water pipe marking must be purple in colour with letters min. 25 mm high and 5 mm stroke and bonded completely around pipe. Marking intervals shall not exceed 2 meters and must be provided at changes of direction and before and after wall, floor, ceiling and roof penetrations.
- .10 Provide 25 mm thick fiberglass insulation to rainwater harvesting supply pipes within building.

Rainwater Retention System

3.2 Storm Water Reuse System Pump

- .1 Install pumps and all equipment associated with Storm Water Reuse System supply shall be installed to Manufacturer direction. Supplier shall coordinate all devices equipment supplied for this Section for satisfactory operation of system and shall confirm in writing. Obtain all approval prior to installation.

END OF SECTION

Domestic Water Heaters

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Summary

- .1 Section Includes
 - .1 Labour, products, equipment and services necessary to complete the work of this Section.

1.3 Codes and Regulations

- .1 Conform to the latest edition of the Codes and Standards referenced herein.
- .2 Pressure Ratings
 - .1 Suitable for working pressure as scheduled.
- .3 Efficiency and Stand-by Loss Ratings
 - .1 To ASHRAE/IES 90.1
- .4 Relief Valves
 - .1 Temperature, Pressure and Combination: to CAN1-4.4, or ANSI Z21.22

1.4 Submittals

- .1 Shop Drawings
 - .1 Submit shop drawings in accordance with Section 013300.
 - .2 Provide certification for compliance to ASHRAE 90.1 for efficiency and stand-by loss ratings.
- .2 Operation and Maintenance Data
 - .1 Submit printed operation instructions and maintenance data in accordance with Section 017700.

PART 2 - PRODUCTS

2.1 General Requirements

- .1 Connections up to NPS 2 to be screwed and over NPS 2 to be flanged.
- .2 Water heaters to be factory pre-piped and pre-wired, except where devices are specified to be shipped loose to be installed by others.

Domestic Water Heaters

2.2 Closeout Submittals

- .1 Provide maintenance and engineering data for incorporation into manual specified in Section 017700.

2.3 DHW Heater

- .1 Electric, 189 litres, glass lined, pre-wired CSA, 2 elements of 3000 Watts each wired for simultaneous operation, 208 V / 3 phase, drain valve, T&P relief valve.

2.4 Trim And Instrumentation

- .1 Drain valve: NPS 1 with hose end.
- .2 Thermometer: 100 mm dial type with red pointer and thermowell filled with conductive paste.
- .3 Pressure gauge: 75 mm dial type with red pointer, syphon, and shut-off cock.
- .4 Thermowell filled with conductive paste for control valve temperature sensor.

2.5 Pneumatic Tank

- .1 Provide one (1) ASME approved Amtrol Model ST-12C expansion tank and pipe up as shown on Schematic Diagram.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's recommendations and authority having jurisdiction.
- .2 Provide valved drain from tank to nearest funnel or hub drain.
- .3 Pipe-up T&P relief valve down to floor.
- .4 Connect up to cold water supply lines and domestic hot water distribution piping.
- .5 Provide thermometer on outlet piping from hot water tank and as shown.
- .6 Provide all required wiring from outlet provided by Division 26.
- .7 Install pneumatic tank at high level on wall to approval.

3.2 Field Quality Control

- .1 Manufacturer's factory trained, certified Engineer to start up and commission DHW heaters.

END OF SECTION

Plumbing Specialties and Accessories

PART 1 - GENERAL

1.1 General

- .1 Conform to sections of division 1 as applicable.
- .2 Conform to section 21 05 00 general mechanical requirements.

1.2 Summary

- .1 Section Includes
 - .1 Labour, products, equipment and services necessary to complete the work of this Section.

1.3 Submittals

- .1 Shop Drawings
 - .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Operation and Maintenance Data
 - .1 Submit printed operation instructions and maintenance data in accordance with Section 01 79 23.
- .3 General LEED Requirement Section 01 35 20.

1.4 Reference Standards

- .1 Reduced pressure type backflow preventers to: CAN/CSA B64 standard series

PART 2 - PRODUCTS

2.1 Back Flow Preventers

- .1 General
 - .1 Acceptable Manufacturers:
 - .1 Watts
 - .2 Honeywell/Braukmann
 - .3 Zurn Wilkins
 - .4 Conbraco
 - .5 Approved Alternate

Plumbing Specialties and Accessories

.2 Vacuum Breakers, Pressure Type

- .1 To CSA B64.1.2 for back-siphonage, no back pressure.
- .2 Working pressure: to 1000 kPa
- .3 Working temperature: to 60oC
- .4 NPS ½ to NPS 2: Anti-siphon pressure vacuum breaker complete with bronze body and spring loaded single float and disc with independent first check, shut off valves and bronze type test cocks for winterization draining. Springs should be of stainless steel construction.

.3 Reduced Pressure Principle Backflow Preventer Assembly

- .1 To CSA B64.4.
- .2 Two independent check valves with captured springs, access for maintaining internals, replaceable valve seats, intermediate relief valve, shut-off valves and ball type test cocks.
- .3 Working pressure: to 1200 kPa
- .4 NPS ½ to NPS 2: complete with quarter turn shut-off valves and bronze strainer.
- .5 NPS 2½ to NPS 10: complete with non-rising stem, shut-off gate valves and strainer.
- .5 Backflow preventer test kit: pressure gauge, colour coded needle valves and hose, adaptors, replaceable hose filters and valve stem seals, carrying case.

2.2 Miscellaneous Equipment

.1 Water Pressure Reducing Valve

- .1 Spring loaded, field adjustable, strainer, replaceable seat. Access for servicing internal components. Products from the following manufacturers are acceptable.
 - .1 Watts
 - .2 Zurn
 - .3 Conbraco
 - .4 Approved Alternate

.2 Shock Absorbers

- .1 Water hammer arrestor, sized in accordance with P.D.I.-WH201. Products from the following manufacturers are acceptable.
 - .1 Watts
 - .2 Zurn Shoktrol
 - .3 PPP Inc.
 - .4 Approved Alternate

Plumbing Specialties and Accessories

2.3 Floor Drains / Funnel Floor Drains

- .1 Floor drains: to CSA B79 with square tops Zurn / JR Smith or approved equal manufacturer are acceptable.
- .2 Cast iron body square, adjustable head, nickel bronze square strainer, integral seepage pan, and clamping collar. Zurn 415B5-P / JR Smith 2005A.
- .3 Combination funnel floor drain; cast iron body with integral seepage pan, clamping collar, nickel-bronze adjustable head strainer with integral funnel. Zurn 415-BFP/ JR Smith 2320 / 3590.
- .4 Planters; cast-iron body with integral seepage pan, clamping collar, nickel-bronze adjustable head strainer, vandal-proof dome and standpipe, stainless steel screen.
- .5 Provide 1940-1-32 large floor drain as noted on kitchen drawings Zurn Model 1902 or equal.
- .6 For seamless floor provide surface clamping device for each unit – Zurn 415R-P, JR Smith 2051.

2.4 Cleanouts

- .1 Cleanout plugs: heavy cast iron male ferrule with brass screws and threaded brass or bronze plug. Sealing-caulked lead seat or neoprene gasket with square top.
- .2 Access covers:

Wall access: face or wall type, polished nickel bronze square cover with flush head securing screws, bevelled edge frame complete with anchoring lugs.

Floor access: round, cast iron body and frame with adjustable secured nickel bronze square top, cast box with anchor lugs and:

Plugs: bolted bronze with neoprene gasket.

Cover for Unfinished Concrete Floors: nickel bronze square top, gasket, vandal-proof screws. Zurn 1602SP.

Cover for Terrazzo Finish: polished nickel bronze with recessed square cover for filling with terrazzo, vandal-proof locking screws. Zurn 1602SP-Z.

Cover for Tile and Linoleum Floors: polished nickel bronze with recessed square cover for linoleum or tile infill, complete with vandal-proof locking screws. Zurn 1602SP-TX.

Cover for Carpeted Floors: polished nickel bronze with deep flange cover for carpet infill, complete with carpet retainer vandal-proof locking screws with square top. Zurn 1602SP-CM.

Seamless Floors: Similar to above fitted with surface clamping device and square top. Zurn 1602R0SP.

2.5 Non-Freeze Wall Hydrants (Exterior and Interior 19 mm Hose Bibb)

- .1 Recessed with integral vacuum breaker encased box, NPS 3/4 hose outlet, removable operating key. Polished bronze finish. Hose bibb shall be Zurn (or equal) Model 1320. Provide similar unit for each Washroom.

Plumbing Specialties and Accessories

2.6 Pressure Regulators

- .1 NPS2 and over, semi-steel bodies, Class 125, flanged: to ASTM A126, Class B.
- .2 Semi-steel spring chambers with bronze trim.

2.7 Hose Bibbs and Sediment Faucets

- .1 Bronze construction complete with integral back flow preventer, hose thread spout, replaceable composition disc, and chrome plated in finished areas.

2.8 Water Meters

- .1 Comply with AWWA and as approved by local P.U.C. and Region of Peel.
 - .1 Size: 50 mm for incoming water main
 - .2 19 mm for domestic water heater make-up
 - .3 19 mm for domestic hot water recirc line.
- .2 Accessories:
 - 4–20 million pulse reader for B.M.S.
 - Backflow preventer
 - Pressure reducing valve
 - Shutoff valves at inlet and outlet
 - Valved bypass line

2.9 Trap Seal Primers

- .1 Provide electronic trap seal primer in a fully recessed box as manufactured by PPI and prime each trap.

2.10 Strainers

- .1 Y type with 20 mesh, monel, bronze or stainless steel removable screen.
- .2 Bronze body, screwed ends, with brass cap.

2.11 Electric Pipe Tracing

- .1 Electric pipe tracings shall be two rows of Raychem 8XL trace c/w thermostat, splice kit seals, cables and other required accessories rated for 120V/1/60. Division 16 to provide outlet only.

2.12 Grease Trap

- .1 Zurn (or approved equal) model 1170-500 flow rate 20 gpm, fully recessed with fully recessed non skid cover.

Plumbing Specialties and Accessories

PART 3 - EXECUTION

3.1 Manufacturer's Instructions

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

3.2 Installation

- .1 Install in accordance with provincial codes, and local authority having jurisdiction.
- .2 Install in accordance with manufacturer's instructions and as specified.

3.3 Cleanouts

- .1 Install cleanouts at base of soil and waste stacks, and rainwater leaders, at locations required code, and as indicated.
- .2 Bring cleanouts to wall or finished floor unless serviceable from below floor.
- .3 Building drain cleanout and stack base cleanouts: line size to maximum NPS4.

3.4 Non-Freeze Wall Hydrants

- .1 Install 600 mm above finished grade unless otherwise indicated.

3.5 Water Hammer Arrestors

- .1 Install on branch supplies to fixtures or group of fixtures.

3.6 Back Flow Preventors

- .1 Install in accordance with CSA-B64 Series, where indicated and elsewhere as required by code at maximum 1500 mm AFF. Unless noted, provide reduce pressure type backflow preventer.
- .2 Pipe discharge to terminate over nearest drain and or service sink.
- .3 Provide at locations shown on drawings.
- .4 Provide at downstream of water meter to incoming water service.
- .5 Install backflow preventers where shown on drawings, in accordance with manufacturers recommendations, and as follows:
 - .1 Locate reduced pressure principle backflow prevention devices at 1200 mm above finished floor.
 - .2 Locate vacuum breaker devices exposed as close to fixture connection as possible.
 - .3 Provide drain collector at relief valves and NPS 3/4 drain from reduced pressure principle backflow prevention devices and run drain to nearest floor drain.
- .6 Testing:
 - .1 Test each unit on site and submit test certificates.

Plumbing Specialties and Accessories

- .2 Provide inspection tag on each such device.
- .3 Submit test results to Building Plumbing Inspector and Consultant.

3.7 Trap Seal Primers

- .1 Install for floor drains and each trap.
- .2 Install soft copper tubing to each trap.
- .3 Provide valved cold supply water line from main to each electronic trap seal primer and pipe to each trap.

3.8 Strainers

- .1 Install with sufficient room to remove basket.

3.9 Water Meters

- .1 Install water meter approved by local water authority in accordance to their requirements.
- .2 Install water with valved bypass line.

3.10 Make-up Water Valves

- .1 Provide in domestic water lines to systems where shown c/w backflow preventer.

3.11 Water Pressure Reducing Valves

- .1 Locate in domestic water lines where pressure is more than 552 kPa.
- .2 Provide pressure gauge on upstream and downstream side of PRV, complete with pet-cock.
- .3 Provide pressure relief valve suitably sized and pipe to drain.

3.12 Shock Absorbers

- .1 Locate shock absorbers in hot and cold water lines:
 - .1 At far ends of mains
 - .2 At branch lines to each flush valve and quick closing valve
 - .3 At dead ends of branch piping or to groups of plumbing fixtures
 - .4 At isolated individual plumbing fixtures

3.13 Non Freeze Wall Hydrants

- .1 Verify wall thickness at each hydrant to ensure correct hydrant length.

3.14 Hose Bibbs

- .1 Mount 1050 mm above finished floor.
- .2 Provide a line mounted vacuum breaker selected for continuous pressure.

3.15 Electric Pipe Tracings

- .1 Electrically traced all pipes subject to freeze.
- .2 Provide labels stating "Electric Traced" at every 2000 mm intervals.

Plumbing Specialties and Accessories

- .3 Install to Manufacturer's direction. Submit confirmation letter from Manufacturer.

3.16 Grease Trap

- .1 Install fully recessed in floor.
- .2 Provide vent lines to suit code requirements.

3.17 Start-Up

- .1 General:
 - .1 In accordance with General Requirements.
- .2 Timing: start-up only after:
 - .1 Pressure tests have been completed.
 - .2 Disinfection procedures have been completed.
 - .3 Certificate of static completion has been issued.
 - .4 Water treatment systems operational.
- .3 Provide continuous supervision during start-up.

3.18 Testing And Adjusting

- .1 General:
 - .1 In accordance with General Requirements, supplemented as specified.
- .2 Timing:
 - .1 After start-up deficiencies rectified.
 - .2 After certificate of completion has been issued by authority having jurisdiction.
- .3 Adjustments:
 - .1 Verify that flow rate and pressure meet required criteria.
 - .2 Make adjustments while flow rate.
- .4 Floor drains:
 - .1 Verify operation of trap seal primer.
 - .2 Prime, using trap primer. Adjust flow rate to suit site conditions.
 - .3 Check operations of flushing features.
 - .4 Check security, accessibility, removability of strainer.
 - .5 Clean out baskets.
 - .6 Provide prime line and vent line to each floor drain trap.
- .5 Vacuum breakers, backflow preventers, backwater valves:
 - .1 Test tightness, accessibility for O&M of cover and of valve.
 - .2 Simulate reverse flow and back-pressure conditions to test operation of vacuum breakers, backflow preventers.

Plumbing Specialties and Accessories

- .3 Verify visibility of discharge from open ports.
- .6 Access doors:
 - .1 Verify size and location relative to items to be accessed.
- .7 Cleanouts:
 - .1 Verify covers are gas-tight, secure, yet readily removable.
- .8 Water hammer arrestors:
 - .1 Verify proper installation of correct type of water hammer arrester.
- .9 Wall, Ground hydrants:
 - .1 Verify complete drainage, freeze protection.
 - .2 Verify operation of vacuum breakers.
- .10 Pressure regulators, PRV assemblies:
 - .1 Adjust settings to suit locations, flow rates, pressure conditions.
- .11 Strainers:
 - .1 Clean out repeatedly until clear.
 - .2 Verify accessibility of cleanout plug and basket.
 - .3 Verify that cleanout plug does not leak.
- .12 Training:
 - .1 Training of O&M Personnel, supplemented as specified.
 - .2 Demonstrate full compliance with Design Criteria.

END OF SECTION

Plumbing Fixtures

PART 1 - GENERAL**1.1 General**

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Summary

- .1 Section Includes
 - .1 Labour, products, equipment and services necessary to complete the work of this Section.

1.3 Submittals

- .1 Shop Drawings
 - .1 Submit shop drawings in accordance with Section 013300.
- .2 Operation and Maintenance Data
 - .1 Submit printed operation instructions and maintenance data in accordance with Section 01 78 23.
- .3 LEED Requirement Section 01 35 20

PART 2 - PRODUCTS**2.1 Plumbing Fixtures**

- .1 General Requirements
 - .1 CSA approved plumbing fixtures and fittings, of make, type and size specified herein.
 - .2 Comply with the current water saving ratings of the Ontario Building Code, and ASHRAE/IEEE 90.1.
 - .1 Lavatories – 1.3 LPM
 - .2 Water closets – 4.2 LPM
 - .3 Sinks – 4.5 LPM
 - .3 Plumbing supplies and fixture trim material to be of CSA approved plumbing brass with chrome plated finish, and of make and type specified. Each item to bear name of manufacturer or identifying trademark.
 - .4 Provide plumbing fixtures shown or noted complete with necessary fittings and escutcheons. Provide floor supported chair carrier for each wall mount fixture. Plastic escutcheons are not acceptable. Fixtures and fittings shall conform to C.S.A. B45.1, B45.4 and B125 amended to date.

Plumbing Fixtures

- .5 Verify each fixture with millwork provided by Another Section. No extra will be allowed if revisions is required due to millwork provided by Another Section.
- .6 VERIFY mounting height of all fixtures with Architect BEFORE ROUGH-IN. Mount each handicap fixture to Code requirement. Adjust flush valves to provide adequate flush with minimum water. Provide all wiring to electrically operated units from outlets provided by Division 26.

.7 Alternate Equipment:

Fixtures

- .1 Kohler
- .2 Toto
- .3 Zurn
- .4 or Approved Alternate

Faucets

- .1 Chicago
- .2 Zurn
- .3 or Approved Alternate

Fixture Trim

- .1 Powers
- .2 Zurn
- .3 or Approved Alternate

Flush Valves

- .1 Zurn
- .2 Sloan
- .3 Moen
- .4 Or Approved Alternate

Mop Sink

- .1 Acorn
- .2 Zurn
- .3 Acorn
- .4 or Approved Alternate

Plumbing Fixtures

.8 Toilet - Wall Mtd. Flush Valve (W-1)- Standard

AFWALL 3353.101 back spud 4.2L 'Water Saver' toilet, vitreous china elongated siphon jet action bowl, 38 mm back spud, with flange bolts, bolt caps, flange and gasket. Delta 1600T6102 sensor operated hard wire complete with transformer flush valve set to 4.2 L / flush, C.P. quiet action diaphragm type with vacuum breaker, angle stop, pressure loss check and with non-hold open feature. Centoco #1500CC seat, Bemis #1955C elongated heavy duty solid plastic white open front less cover, with check hinges and chromated steel posts, washers and nuts. Provide floor support chair carrier.

.9 Toilet - Wall Mtd. Flush Valve (W-2) - Handicap

AFWALL 3353.101 back spud 4.2L 'Water Saver' toilet, vitreous china elongated siphon jet action bowl, 38 mm back spud, with flange bolts, bolt caps, flange and gasket. . Delta 1600T6102 sensor operated hard wire flush valve complete with transformer, set flush valve to 4.2 L / Flush, C.P. quiet action diaphragm type with vacuum breaker, angle stop, pressure loss check and with non-hold open feature. Centoco #820TM seat, Bemis #1850TT elongated heavy duty solid plastic white open front with cover, with check hinges and chromated steel posts, washers and nuts. Provide floor support chair carrier. Locate sensor to clear open seat.

.10 Lavatory (L-1)

Lavatory and faucet provided by Another Section. Provide open grid strainer, with offset waste 47T312 angle supply with S.D. stops, 33T311 'P' trap and escutcheons plates.

.11 Lavatory L-2 Wall Mount Handicap

American Standard 0955.000.0059.020. Delta 591T0298, 0.34 gpm c/w mixing valve and transformer, stainless steel recessed box, open grid strainer, with offset waste 47T312 angle supply with S.D. stops, 33T311 'P' trap and escutcheons plates.

.12 Bottle Filter (BF)

Elkay Model EZWS-SFGRN8K pushbutton refrigerated, stainless steel, push button drinking fountain sensor operated bottle filler, lead free NSF certified, p-trap and stops on supply pipe.

.13 Mop Service Basin (MSB)

Fiat TSB-200 terrazzo mop basin, complete with stainless steel strainer and 75 mm outlet; Watts 909 backflow preventer on each supply, C.P. Delta 28C2383 hose and mounting brackets wall mounted faucet with hose outlet and integral vacuum breaker mounted 900 mm above floor; 75 mm 'P' trap under floor. Caulk and seal floor basin to rear wall and floor to approval.

Plumbing Fixtures

.14 (DW) Dishwasher

Supplied by Another Section installed by this Section. Rough-in and connect up domestic dishwasher supplied by Owner where shown. Provide 50 mm for commercial and 38 mm for domestic, trapped waste, 38 or 32 mm vent, 13 mm stops, and W-5 Shockstop on each supply.

.15 (S-1) One Compartment S.S. Sink

Frank UCS 4608 undermount single compartment, mirror finished ledge, with crumb cup strainer, sound deadening. `P` Trap cast brass, 38 mm with cleanout, union and escutcheon. Trim fitting Delta 26C3243.0611-77A, 1 gpm, Faucet, C.P. 203 mm C.C. deck mounted, stainless steel finish, swing spout with vandal proof flow aerator and cast metal lever handle. 33T311 `P` Trap, Connect with S.S. flexible tubes and 12.7mm rough Stops on supply piping.

.16 (S-2) Art Room Sink– Art Room

Kindred LBs7312P, 572 mm x 521 mm x 343 mm deep, type 302, single compartment vanity sink, round corner sink, with 38 mm waste. Delta 26C3243.0611-77A, 1 gpm, swing spout stainless steel finish faucet aerator and spray hose, 38 mm copper `P` trap with cleanout. Provide Zurn #1180SS sediment interceptor at outlet. Provide minimum of 300 mm space for basket removal.

.17 Eye/Face Wash (EW/SH)

Acorn Safety Model S2340-FPB-combination eye/face wash, showerhead, ET71-2-OTG-BTS mixing valve with outlet temperature gauge.

PART 3 - EXECUTION

3.1 Installation

.1 Water Flow Rate

- .1 Adjust to provide specified water flow rate based on manufacturers calibration data for valve open time vs. inlet water pressure.
- .2 Install each fixture to Manufacturer's directions. Provide all accessories and trims as required.
- .3 Provide wiring to all fixtures from outlet provided by Division 26.

END OF SECTION

Valves

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Related Sections

- .1 23 21 16 Section "Hydronic System, Steel"
- .2 23 05 54 Section "Mechanical Identification"
- .3 23 09 33 Section "Building Management System"
- .4 23 21 14 "Hydronic Specialties"

1.3 Summary

- .1 This Section includes the following general-duty valves:
 - .1 Bronze gate valves.
 - .2 Cast-iron gate valves.
 - .3 Bronze globe valves.
 - .4 Cast-iron globe valves.
 - .5 Ball and plug valves.
 - .6 Butterfly valves.
- .2 This Section also includes:
 - .1 Flow Measuring Equipment

1.4 Submittals

- .1 Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

Valves

PART 2 - PRODUCTS

2.1 Hot Water

- .1 All gate, globe throttling and check valves shall be Crane, Jenkins, Newman Hattersley, Keystone, DeZurik or Toyo. Ball valves, plug valves, and butterfly valves shall be as listed below or approved equal. Shutoff valves for all general service purposes shall be ball valves, not gate valves.

Throttling, control or bypass valves: globe type, brass up to and including 50 mm size with stainless steel seats and discs. Larger size valves shall be butterfly valves as for shut-off valves but with manual gear operator.

Provide on piping to and from each hot water coil and unit heater necessary shut-off valves full size of line for isolating same on system side of unions.

Victaulic valves meeting above criteria may be used in grooved piping systems.

Note that, balancing shall be achieved using specified circuit setter along with a ball or butterfly shutoff valve.

Where grooved piping systems are used, Victaulic Vic-300 (for steel piping systems) and Series 608 (for copper piping systems) or Grinnel Gruvlok 7700 or 8000 GR butterfly valves may be used. Note that extended stem is required to allow proper insulation.

Armstrong 4 turn balancing valves may be used in lieu of B & G Circuit Setters or Taco.

Valves shall be compatible with ethylene glycol.

2.2 Flow Measuring Equipment

- .1 Provide in each hot water branch pipe an S.A. Armstrong circuit balancing valve to suit pipe size.
Valves shall be equipped with ports to measure flow.
- .2 Fittings up to 2" size shall be Model CBVI screwed end circuit balancing fitting with shutoff/balancing valve, drain connection and meter connections. Fittings over 2" size shall be Model CBV-11 flanged end circuit balancing fitting with valved meter connection and shutoff/balancing valve. Fittings shall be rated for 125 psi working pressure.
- .3 Supply one Armstrong "Compuflow" digital meter complete with temperature probe, carrying case, hoses and operating instructions. Turn over to Consultant on completion of system balancing.
- .4 All balancing valves shall have 5 full 360o turn from open to closed position.
- .5 CBV's shall be compatible with ethylene glycol.

Valves

.6 Acceptable Products:

- .1 Taco Ltd.
- .2 Tour & Anderson
- .3 ITT Bell & Gossett
- .4 Approved Alternate

PART 3 - EXECUTION

3.1 Valve Installation

- .1 Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- .2 Install valves with unions at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- .3 Locate valves for easy access and provide separate support where necessary.
- .4 Install valves in horizontal piping with stem at or above center of pipe.
- .5 Install valves in position to allow full stem movement.
- .6 Install drain valve at the low point of each zone.

3.2 Joint Construction

- .1 Refer to Division 21 05 00 Section "General Mechanical Requirements" for basic piping joint construction.
- .2 Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- .3 Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.3 Adjusting

- .1 Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION

Hangers Support for Piping and Equipment

PART 1 - GENERAL**1.1 General**

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Related Sections

- .1 Conform to Section 23 21 16 Hydronic Systems, Steel.

1.3 Submittals

- .1 Shop Drawings: Prepare and submit shop drawings for equipment covered by this Section including upper, middle and pipe attachments, riser clamps, shields and saddles, and sway braces.

PART 2 - PRODUCTS**2.1 General**

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.2 Pipe Hangers

- .1 Finishes
 - .1 Pipe hangers and supports: painted with zinc-rich paint after manufacture.
 - .2 Use electro-plating galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .1 Rod: 9 mm UL listed.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed.
- .4 Hanger rods: threaded rod material to MSS SP58:
 - .1 Ensure that hanger rods are subject to tensile loading only.

Hangers Support for Piping and Equipment

- .2 Provide linkages where lateral or axial movement of pipework is anticipated.
- .5 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel black.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .6 Adjustable clevis: material to MSS SP69 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.

2.3 Miscellaneous Steel

.1 General

- .1 Supply and install miscellaneous structural supports, platforms and braces as may be required to hang or support piping unless Drawings or other Sections of Specifications state otherwise.
- .2 Submit detailed shop drawings to Consultant for review before commencing fabrication.

.2 Materials and Fabrication

- .1 Conform to CAN/CSA-S16-14 for materials, design of details and execution of work.
- .2 Use welded construction wherever practicable, with bolted joints allowed for field assembly using high strength steel bolts. Chip welds to remove slag, and grind smooth.
- .3 Conform to latest issue of following CSA Specifications.
 - CSA W47.1, for qualification of welders
 - CSA W48.1-M, for electrodes (only coated rods allowed)
 - CSA W59-M, for design of connections and workmanship
 - CSA W117.2, for safety

.3 Painting and Cleaning

- .1 Touch up minor damage to finish on equipment with standard factory applied baked enamel finish. If, in Consultant's opinion, damage is too extensive to be remedied by touch up, replace damaged equipment.
- .2 Clean steel by scraping, wire brushing or other effective means to remove base scale, rust, oil, dirt or other foreign matter.
- .3 Apply 1 coat of zinc chromate iron oxide primer, conforming to CAN/CGSB-1.40-M to miscellaneous steel.

Hangers Support for Piping and Equipment

- .4 In field, touch up bolt heads and nuts, previously unpainted connections and surfaces damaged during erection with primer as herein before specified.
- .5 Give 2 coats of primer to surfaces which will be inaccessible after erection.
- .6 Remove foreign matter from steelwork on completion of installation.
- .7 With exception of prime painting of miscellaneous steel or any other specific requirements as specified above or under respective Sections of Division 15, or equipment otherwise factory painted, painting will be provided under Division 9, Finishes.

2.4 Concrete Inserts

- .1 Install inserts required for attachment of hangers, either for suspension of piping or equipment.
- .2 For masonry or poured concrete construction use expansion type units. Insert into concrete after concrete has cured. Anchors or inserts installed by explosive means shall not be used.

2.5 Acceptable Products

- .1 Beam Clamps
Grinnell
Myatt
Hilti
Approved Alternate
- .2 Pipe Hangers:
Grinnell
Myatt
Hilti
Approved Alternate

PART 3 - EXECUTION

3.1 General Construction Requirements

- .1 Attachment to Building Construction
 - .1 Use welding studs of size not larger than 10 mm (3/8") for attaching miscellaneous materials and equipment to building steel. If weight of materials or equipment require bolts or studs larger than 10 mm (3/8") dia, use steel clips or brackets, secured to building steel by welding or bolting method of attachment as approved by Consultant.

Hangers Support for Piping and Equipment

- .2 Use self drilling expansion type concrete inserts for securing miscellaneous equipment and materials to masonry or concrete construction already in place, of sufficient number and size to prevent concrete from breaking away. Use of powder or power actuated fasteners will not be allowed unless prior written approval is obtained from Consultant.
- .3 Support rods for any suspended item must not be attached to or extended through steel pan type roofs or through concrete slab roofs.
- .4 Provide beam clamps of 2-bolt design and of such type that rod load is transmitted only concentrically to beam web centreline. Use of "C" and "I" beam side clamps and other similar items will not be allowed without written consent of Consultant.
- .5 Where roof or floor framing consists of open web or long span steel joists, ensure that hangers are located at or within 150 mm (6") of joist top or bottom chord panel points, otherwise provide additional structural steel as required where hanger spacing does not coincide with joist spacing. Design suspension assembly such that hanger load is transmitted only concentrically to supporting joist. Do not use "C" and "I" beam side clamps, brackets and other similar, without written consent of Consultant.

3.2 Piping Construction Methods

.1 General

- .1 Unless specified otherwise herein, construct and install piping in accordance with ANSI Sections B31.1 to B31.9 as applicable to service, except that soldered joints will not be permitted in compressed air piping.
- .2 To avoid unnecessary cutting of masonry, provide inserts, sleeves and anchors to other trades for building in as Work proceeds. Arrange with other trades to leave openings, slots and chases to accommodate later installation of mechanical work.

3.3 Pipe Hangers and Supports

.1 General

- .1 Support or suspend piping with necessary hangers, structural supports and/or brackets as indicated on Drawings and/or as required, to prevent sagging, warping and vibration and to allow for movement due to expansion and contraction. Place hangers and supports close to fittings, valves and/or other heavy parts.
- .2 Do not allow loads of any nature to be transmitted through piping connections to equipment not specifically designed for such loads. Where flexible connections are not called for at connections to equipment, support pipe by stands attached to both pipe and supporting structure so that force in any direction is not transmitted to equipment.

Hangers Support for Piping and Equipment

- .3 Provide suitably dampened spring hangers for first 3 supports from equipment connection on piping subject to excessive movement or shock from any source, thermal expansion and contraction, selected in accordance with ANSI B31.1. Where it is evident that no undue loads will be transmitted to equipment by system concerned, i.e. small bore connections to comparatively large equipment, cold service piping not subject to shock, etc., then spring hangers may be omitted and standard hangers used.
 - .4 Use trapeze type hangers where pipes are grouped together, unless specifically indicated otherwise on Drawings. Suspend horizontal member by adjustable rods with locking feature for maintaining level and slope. Space trapeze type hangers based on closest interval required by any pipe supported thereon. Provide any auxiliary steel required to support trapeze between building steel.
 - .5 Do not hang any pipe from another pipe unless specifically indicated on Drawings.
- .2 Hangers
- .1 For insulated piping up to NPS 4 carrying liquids at temperatures 10.5 deg C (51 deg F) and higher, use standard weight clevis steel hangers with level adjustment and locknut.
 - .2 For insulated lines of NPS 4 dia and larger carrying liquids at temperatures 10.5 deg C (51 deg F) or higher, use adjustable roller type hangers with locknuts, and rollers of sufficient width to clear outside diameter of insulation on piping. Support rollers at both ends, either by yoke, swivel type hanger or by 2 adjustable rods with locknuts.
 - .3 For insulated piping carrying liquids at temperature of 10 deg C (50 deg F) or less, use elongated clevis type steel hangers, with clevis of sufficient width to fit over insulation bearing plate.
 - .4 Provide insulation protection bearing plates at hangers and supports for piping carrying liquids at temperature of 10 deg C (50 deg F) or less. Install temporary spacers between plate and pipe equal to thickness of insulation specified. (Refer to Section 21 07 20, Thermal Insulation for Piping).
 - .5 Bearing plates may be either shop fabricated, or manufactured plates of size required to properly fit outside diameter of pipe insulation.

Hangers Support for Piping and Equipment

.6 Fabricate bearing plates conforming to following table for various pipe sizes:

Pipe Size (NPS) P	Length of plate mm (in)	Thickness of Plate mm (ga)
13 mm thr. 138 mm	130 (5)	1.2 (18)
50 mm	150 (6)	.52 (16)
63 mm	200 (8)	1.52 (16)
75 mm	230 (9)	1.52 (16)
100 mm and up	250 (10)	1.52 (16)

.7 Form bearing plates to outside diameter of adjoining pipe insulation and extend plate up to horizontal centre line of pipe.

.8 For non-insulated piping use clevis type of wrought steel construction with adjustable rod, level locking feature and backnuts.

.9 For copper tubing provide copper coated hangers. Regulations of some municipalities require that copper tubing be taped with plastic tape at hanger location, or hanger be provided with plastic insert. Meet these requirements when required, in which case copper coating may be omitted on hanger.

.10 Attach hanger rods to building structure by means of malleable iron beam clamps, concrete inserts, and/or approved anchors as hereinbefore specified.

.3 Hanger Spacing

.1 For horizontal runs of plumbing and drainage piping comply with hanger spacing requirements of NBC.

.2 For horizontal runs of black or galvanized steel pipe, other than for plumbing service, do not exceed max distances between supports and with min dia rods as follows:

Pipe Size (NPS)	Distance m (ft)	Dia. of Rod mm (in)
Up thru 32 mm	1.8 (6)	10 (3/8)
38 mm	1.8 (6)	10 (3/8)
50 mm	3.05 (10)	10 (3/8)
63 mm & 75 mm	3.66 (12)	12 (1/2)
100 mm	4.27 (14)	16 (5/8)
150 mm	5.18 (17)	19 (3/4)
200 mm	5.79 (19)	22 (7/8)
250 mm & 300 mm	6.71 (22)	22 (7/8)

Hangers Support for Piping and Equipment

- .3 Provide additional hangers in locations where there are concentrated loads such as valves, specialties and other such items.
- .4 For horizontal runs of copper tubing for services other than plumbing, do not exceed 1.8 m (6 ft) between hangers for lines up to and including NPS 3/4 and 2.4 m (8 ft) for lines of NPS 1 and larger.
- .5 For horizontal runs of piping fabricated of PVC, use hanger spacing as recommended by manufacturer.
- .4 Vertical Piping Supports
 - .1 Support vertical plumbing and drainage piping as required by OBC, unless more stringent requirements are specified herein.
 - .2 Support cast iron soil pipe at every floor and other piping at every other floor unless otherwise required by expansion conditions or otherwise specified.
 - .3 Support bottom of riser with base fitting set on concrete pier or by hanger located at top of riser pipe as close to riser as possible.
 - .4 For supports at intermediate floors, use Grinnell Fig. 261 or Myatt or Crane steel extension pipe clamp, bolted securely to pipe. Rest ends of clamp on pipe sleeve or on floor.
 - .5 Provide lateral stability of vertical piping by fabricated brackets or malleable iron, extension type split hangers. Run vertical piping at columns in column webs, on either or both sides of column, unless otherwise directed by Consultant.
- .5 Anchors and Guides
 - .1 Supply and install anchors where indicated on Drawings and/or as required to maintain permanent location of pipe lines. Construct anchors for steel or galvanized pipe of approved steel straps and/or rods and for anchoring copper lines use copper plated anchors or provide insulation bands between tubing and clamps if steel straps or rods are used. Install anchors and guides in approved manner.
 - .2 Acceptable Materials:
 - .1 Crinnell
 - .2 Myatt
 - .3 Crane
 - .4 Adsco
 - .5 Hunt
 - .6 Approved Alternate

END OF SECTION

Noise & Vibration Control

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General mechanical Requirements.

1.2 RELATED SECTIONS

- .1 HVAC Fans 23 34 00
- .2 Heat Pumps Section 23 81 40
- .3 Heat Recovery Equipment Section 23 72 13

1.3 SUBMITTALS

- .1 **Shop Drawings:** Prepare and submit shop drawings for all equipment and systems covered in this Section.
- .2 Data on vibration isolation devices including physical dimensions, spring data, isolation efficiency based on rigid support points.

PART 2 - PRODUCTS

2.1 Manufacturers

- .1 Acceptable manufacturers of noise and vibration control hardware:
 1. Vibron
 2. Vibro-Acoustics
 3. Korfund-Sampson
 4. Approved Alternate

2.2 Materials

.1 General

- .1 Furnish all noise and vibration control hardware supplied by a single supplier.
- .2 Carry out the work in this section in accordance with manufacturer's instructions (and supervision where required) and only by workmen experienced in the installation of such systems.

Noise & Vibration Control

.2 Vibration Control

- .1 Furnish vibration isolation hardware of the types referred to below, each with detailed specification as outlined separately:

.3 Isolator Requirements

- .1 Ensure that the vibration isolation supplier examines and conforms to the overall requirements for the project in accordance with the requirements specified herein.
- .2 Take into consideration the RPM of equipment in determining the disturbing frequency on all fans, pumps, compressors, etc.
- .3 Establish vibration isolation requirements from equipment manufacturers certified shop drawings and performance data.
- .4 Select spring isolators from the manufacturer's catalogue inventory wherever possible.
- .5 Should deflection requirements warrant the use of special springs, provide complete design data to the Consultant with the review drawings.
- .6 Supply hanger type spring isolators with neoprene or composition pads at both ends of the spring.

.4 Isolating Base

- .1 Provide for evaporative water cooler, Vibro-Acoustic continuous isolation base consisting of galvanized section rails formed to fit equipment with flexible air joining upper and lower rail sections.
- .2 Rails shall have cadmium plated stable springs selected to provide 50 mm minimum deflection with 50% additional travel to solid.
- .3 Each isolating assembly shall have neoprene cushioned wind restraints which allow 6.4 mm movement before engaging in resisting wind loads in any lateral direction.
- .4 Isolation rail assembly shall be shipped assembled.

PART 3 - EXECUTION**3.1 General**

- .1 Install all equipment, piping and ductwork in accordance with good noise and vibration control engineering practice and Manufacturer's installation instructions in order to meet the following requirements:
- .2 Noise created by mechanical equipment must not exceed the levels listed below:
Room N.C. Levels
Offices 35
- .3 Vibration created by mechanical equipment must be below the level of perception in all occupied areas of the building.

Noise & Vibration Control

3.2 Noise Control

- .1 In the selection and installation of equipment, ensure that the equipment does not produce undue amounts of noise and vibration induced noise.
- .2 Sleeve all pipes passing through walls or floor within the first 100 times diameter length from a noise/vibration source, with sleeves at least 50 mm (2") larger than the pipe diameter. After installation of the pipe, pack the periphery with Firestop, ULC listed fireproof, or high density mineral wool (greater than 5 lb/cu.ft.) at not more than 50% compression.
- .3 Caulk the ends of the packing and seal with non-hardening caulk (with colourpak if weatherproof quality is required).
- .4 Similarly, pack and seal all spaces and cracks around ducts passing through Mechanical Room walls or floor, as described above for pipes.
- .5 Provide flexible connection between ducts and equipment (HRV Units, Heat Pumps and Exhaust Fans).

END OF SECTION

Mechanical Identification

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General mechanical Requirements.

1.2 Related Work

- .1 Forced Air Heaters: 23 55 01.
- .2 Air to Air Energy Recovery Equipment Units: 23 72 13
- .3 HVAC Fans: 23 34 24
- .4 Evaporative Water Cooler: 23 65 11
- .5 Heat Pump: 23 81 40
- .6 Pumps: 23 21 23
- .7 Hydronic Systems Steel: 23 21 16
- .8 Thermal Insulation for Piping: 21 07 20
- .9 Valves: 23 05 23
- .10 Heating Boilers: 23 52 00

1.3 Submittals

- .1 Shop Drawings
 - .1 Submit samples and lists of proposed wording for approval before ordering materials or engraving nameplates.
 - .2 Submit a full list of all services to be labeled and the colour and legend proposed for each service.

PART 2 - PRODUCTS

2.1 Acceptable Materials

- .1 Pipe Labels, Identification Tapes and Tags
 - Brady
 - Safety Supply Co.
 - S.M.S.
 - Revere-Seton
 - Approved Alternate

Mechanical Identification

2.2 Manufacturers Nameplates

- .1 Provide metal nameplate on each piece of equipment, mechanically fastened complete with raised or recessed letters.
- .2 Indicate equipment tag number as indicated on Drawings and equipment size, model, manufacturer's name, serial number, performance rating, voltage, cycle, phase and power of motors.

2.3 Equipment Nameplates

- .1 Provide nameplates for all mechanical and electrical equipment installed under this Division, adequately describing the function or use of the particular equipment involved and including equipment number and equipment name generally as listed on the Drawing Schedules. Submit list of nameplates to the Consultant for review. Do not commence fabrication of nameplates until after receipt of Consultant review.
- .2 Fit nameplates to electrical equipment, including, but not limited to: motor starters, pushbutton stations, control panels, time switches, disconnect switches, and contactors or relays in separate enclosures.
- .3 Furnish nameplates of laminated phenolic plastic with white finish and minimum 10 mm (3/8") high black letters.

2.4 Valve Tags and Indexes

- .1 Upon completion of the work, furnish and install a 25 mm (1") dia. brass tag at each valve bearing an Index Number designating the valve. Review valve designation with the Consultant before ordering.
- .2 Provide in duplicate, a typewritten directory mounted in a glazed hardwood frame for each system, giving the valve index number, size, make and Cat. No. and the "service" of each valve and the location of the valve.

2.5 Pipe Identification

- .1 Label all piping installed under this Division to indicate the content and direction of flow. Include the operating pressure or vacuum, as applicable for piping carrying steam, compressed air or vacuum.
- .2 Conform with CGSB 24.3 for primary label colour, and with legend and direction arrows in black. Print legend in full wherever feasible, or a recognized abbreviation of the service involved.
- .3 Where outside diameter of pipe (or insulation) exceeds 75 mm (3"). Provide labels with a minimum width of 64 mm (2-1/2") and 50 mm (2") high letters. Where outside diameter of pipe (or insulation) is 75 mm (3") or less, provide labels of 29 mm (1-1/8") width and 25 mm (1") high lettering. Length of labels as dictated by legend.
- .4 Provide labels of plastic coated tape with self-adhesive backing surface. For installation on insulated pipe, provide adhesive suitable for this application.

Mechanical Identification

2.6 Controls Identification

- .1 Identify all systems, equipment, components, controls and sensors with nameplates of laminated phenolic plastic with white finish and minimum 10 mm (3/8") high black letters.

2.7 System Nameplates

- .1 Colours:

Hazardous: red letters, white background.

Elsewhere: black letters, white background (except where required otherwise by applicable codes).

- .2 Construction:

- .1 3 mm thick [laminated plastic] [or] [white anodized aluminum], matte finish, with square corners, letters accurately aligned and machine engraved into core.

PART 3 - EXECUTION

3.1 General

- .1 Clean all surfaces before painting or attaching adhesive labels.
- .2 Treat any surface which is "dusty" or "chalky" with a sodium silicate solution before application of the labels. After application of labels, apply a clear lacquer, as approved by the Consultant, over the labels, and at least 25 mm (1") beyond perimeter of labels.
- .3 Locate nameplates and identification in conspicuous location to facilitate easy reading from operating floor.
- .4 Do not insulate or paint over nameplates.

3.2 Equipment Nameplates

- .1 Securely fasten nameplates to the equipment with round-head cadmium plated steel self-tapping screws.

3.3 Valve Tags and Indexes

- .1 Attach tags to valve handwheels or operators with a non-ferrous key chain.
- .2 Locate framed indexes where instructed by Consultant.

3.4 Pipe Identification

- .1 Locate labels as follows:
 - .1 At every end of every pipe run, adjacent to the valve or item of equipment serviced.
 - .2 At all valves, tees and changes of direction.
 - .3 On each exposed pipe passing through a wall, partition or floor (one on each side of such wall, partition or floor).

Mechanical Identification

- .4 At intervals of 15 m (50'-0") along every exposed pipe run exceeding 15 m (50'-0") in length.
- .5 At every access point on concealed piping.
- .2 Locate labels so they are visible from 1.5 m (5'-0") above the adjacent floor or platform.

END OF SECTION

Testing, Adjusting & Balancing

PART 1 - GENERAL**1.1 Summary**

- .1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.
- .3 The work under this Section will be done by a qualified Testing and Balancing Company and coordinated and paid for by the General Contractor through the Mechanical Contractor.

1.2 Qualifications of Tab Personnel

- .1 Submit names of personnel to perform TAB to Consultant within 30 days of award of contract.
- .2 Qualifications: personnel performing TAB current member in good standing of AABC and NEBB.
- .3 Quality assurance: perform TAB under direction of supervisor qualified to standards of NEBB.
- .4 Provide documentation confirming qualifications, successful experience.
- .5 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
 - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.
- .6 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .7 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .8 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .9 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .10 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
 - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.

Testing, Adjusting & Balancing

- .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 Purpose Of Tab

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
- .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 Exceptions

- .1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

1.5 Co-Ordination

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.6 Pre-Tab Review

- .1 Review contract documents before project construction is started and confirm in writing to Consultant adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Consultant in writing proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 Start-Up

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23.

Testing, Adjusting & Balancing

1.8 Operation of Systems During Tab

- .1 Operate systems for length of time required for TAB and as required by Consultant for verification of TAB reports.

1.9 Start of Tab

- .1 Notify Consultant 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
 - .3 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .4 Application of weatherstripping, sealing, and caulking.
 - .5 Pressure, leakage, other tests specified elsewhere Division 23.
 - .6 Provisions for TAB installed and operational.
 - .7 The building space is clean and free of construction debris.
- .8 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.
 - .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

Testing, Adjusting & Balancing

1.10 Application Tolerances

- .1 Do TAB to following tolerances of design values:
 - .1 HVAC systems: plus 5%, minus 5%.

1.11 Accuracy Tolerances

- .1 Measured values accurate to within plus or minus 5% of actual values.

1.12 Instruments

- .1 Prior to TAB, submit to Consultant a list of instruments to be used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within 3 months of TAB. Provide certificate of calibration to Consultant.

1.13 Submittals

- .1 Submit, prior to commencement of TAB:
 - Proposed methodology and procedures for performing TAB if different from referenced standard.
- .2 Submit TAB Report to Consultant and Commissioning Authority for review

1.14 Preliminary Tab Report

- .1 Submit for checking and approval of Consultant, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
 - .1 Details of instruments used.
 - .2 Details of TAB procedures employed.
 - .3 Calculations procedures.
 - .4 Summaries.

1.15 TAB Report

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit 6 copies of TAB Report to Consultant for verification and approval, in English in D-ring binders, complete with index tabs.

Testing, Adjusting & Balancing

- .4 Marked up drawings are not acceptable.

1.16 Verification

- .1 Reported results subject to verification by Consultant.
- .2 Provide personnel and instrumentation to verify up to 30% of reported results.
- .3 Number and location of verified results as directed by Consultant.
- .4 Pay costs to repeat TAB as required to satisfaction of Consultant.

1.17 Settings

- .1 After TAB is completed to satisfaction of Consultant, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.18 Completion of TAB

- .1 TAB considered complete when final TAB Report received and approved by Consultant & reviewed by Commissioning Authority.

1.19 Air Systems

- .1 Standard: TAB to most stringent of TAB standards of AABC, NEBB and SMACNA.
- .2 Do TAB of following systems, equipment, components, controls:
 - .1 Heat pumps
 - .2 Energy Recovery Ventilator
 - .3 Exhaust Fans
 - .4 Controls
- .3 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .4 Locations of equipment measurements: to include as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .5 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).
- .6 Provide systems leakage tests to SMACNA Class 12 requirements.

Testing, Adjusting & Balancing

1.20 Hydronic Systems

- .1 Standard: TAB to most string of TAB standards of AABC, NEBB & SMACNA.
- .2 Do TAB of following systems, equipment, components, controls
 - .1 Pumps
 - .2 Heat Pumps
 - .3 Controls
- .3 Measurements to include as appropriate for systems, equipment, components control: water flow rate, pressure drop and temperature, RPM, electrical power, voltage, noise, vibration.
- .4 Location of equipment measurement to include as appropriate:
 - .1 Balancing Valves
 - .2 Controllers Controlled Devices.
- .5 Locations of system measurements to include as appropriate:
 - .1 Main supply pipes
 - .2 Branch pipes
 - .3 CBV at each heat pump.
 - .4 Triple daily value at pumps.

END OF SECTION

Thermal Insulation for Piping

PART 1 - GENERAL

1.1 General

- .1 Section 01 40 00: Quality Requirement
- .2 Section 01 41 000: Regulatory Requirement
- .3 Conform to Mechanical General Requirements Section 210500 as applicable.

1.2 Related Sections

- .1 Hydronic Systems - Steel: Section 23 21 16.

1.3 Submittals

- .1 Shop Drawings: Before ordering any insulating materials, submit to the Consultant a list of proposed insulation materials, exterior jackets and adhesive for the various services and equipment on the project. Deviation from the approved list will not be allowed.

PIPING – Pipe Insulation Thickness							
Fluid Design Operating Temperature 0C	Insulation Conductivity		Pipe Size (mm) and Insulation Thickness (mm)				
	Conductivity W/m-K	Mean Rating Temp. 0C	<25	25 to 40	40 to 100	100 to 200	>200
10 - 20	0.032 – 0.040	38	38	38	51	51	51

- .2 Samples: Before ordering any insulation materials, prepare a sample board with a cross-section sample of all types of insulation, including exterior jacket, properly identified for the various services and equipment on the project and state types of adhesives used. Submit the sample board to the for his review and, after review and acceptance, the sample board will be kept in the 's site office for the duration of the project for reference. Deviation from the accepted samples will not be allowed.

 Thermal Insulation for Piping

PART 2 - PRODUCTS**2.1 Unburied Ground Loop**

- .1 Fibrous glass split sectional pipe insulation of the thickness hereinafter specified with factory applied vapour barrier jacket and self-seal lap joint.

Acceptable Products

Owens Corning Canada Inc.	High Temp 1200
Manson	Alley K with APT jacket
Fibrex Insulations Inc.	Fibrex Coreplus 1200

- .2 Fire retardant elastomeric closed cell foam or neoprene tubing of 10 mm (3/8") nom. thickness may be used instead of fibrous glass insulation on hot water runouts to plumbing fixtures, not exceeding 1.5 m (5'-0") in length, applied in accordance with the manufacturer's printed instructions using the recommended adhesive.

Acceptable Products

Armstrong AP/Armaflex
Nomaco Therma-Cel

2.2 Condensate Drain

- .1 Insulate condensate drain with fibrous glass split sectional pipe insulation of 25 mm (1") thickness with factory applied vapour barrier jacket and self-seal lap joint.

Acceptable Products

Owens Corning Canada Inc.	High Temp 1200
Manson	Alley K all purpose with APT jacket
Fibrex Insulations Inc.	Fibrex Coreplus 1200

2.3 Equipment Drain Lines, Safety Valve Vents, etc.

- .1 Insulate equipment drains carrying liquids at 38 C (100 F) or higher temperature, and safety valve vent piping to a height of 2.4 m (8 ft.) above any floor, step, catwalk, or platform from which personnel would be within reach of such piping with 25 mm (1") thick insulation. Insulate heat pumps condensate drain lines with 25 mm thick pipe insulation.

Acceptable Products

Owens Corning Canada Inc.	850 with ASJ
Manson	Alley K with APT jacket
Fibrex Insulations Inc.	Fibrex Coreplus 1200
Knauf	

Thermal Insulation for Piping

Acceptable Products Mineral Wool

Owens Corning Canada Inc.

SSL II pipe Insulation

Fibrex Insulations Inc.

Fibrex Coreplus 1200 (metal jacket

PART 3 - EXECUTION

3.1 General

- .1 Perform insulation work using qualified insulation applicators, in accordance with latest trade application methods and to the Consultant approval.
- .2 Clean all surfaces to be insulated to remove grime, grease, oil, moisture or other matter to ensure that insulation is applied to clean dry surfaces.
- .3 Apply insulation under ambient temperature conditions in accordance with insulation or adhesive manufacturer's recommendations.
- .4 Do not apply insulation until piping and heat tracing, has been tested, inspected, verified, and accepted.
- .5 Apply insulation neatly and tightly in unbroken lengths and with ends of sections firmly and squarely butted or engaged together. Lap canvas or other specified wrapping over all joints and thoroughly cement down with adhesive. Extend insulation through sleeves in walls (except fire walls) or other openings in building to make insulation and vapour barrier continuous and of uniform diameter.
- .6 Terminate insulation at each side of fire walls and pack the space between wall sleeve and duct or pipe as specified in Section 210500.
- .7 Where asbestos-containing insulation has been removed from existing piping, reinsulate (to same extent as removal work) or (to extent as indicated on Drawings). Maintain same thermal value as existing.
- .8 Replace insulation removed from existing piping to make tie-in connections with new insulation. Cut back existing insulation a sufficient distance to make a neat and firm butt joint between old and new insulation.
- .9 At expansion joints in piping, apply insulation over a sleeve of 1.6 mm (16 gauge) metal, fabricated to fit around expansion joint without restricting its movement. Fabricate sleeve so it can be removed to allow for the repacking and lubrication of expansion joint without damaging the adjoining insulation. Extend sleeves a minimum of 75 mm (3") longer than expansion joint, fit with insulation retaining flanges and with a means of maintaining the position of sleeve over expansion joint.
- .10 Where piping is specified to be heat traced, provide oversized insulation to accommodate tracing cable specified in Electrical Specifications.

3.2 Insulation Protection Bearing Plates

- .1 Each mechanical trade will supply and install bearing plates and temporary spacers at each hanger and support on insulated cold piping or tubing as specified in Section 230529 – Hangers Supports for Piping and Equipment.

Thermal Insulation for Piping

- .2 Remove temporary spacers and install a section of asbestos-free calcium silicate insulation extending at least 150 mm (6") beyond each end of the bearing plate.
- .3 Bond insulation to the bearing plate with Foster 85-20 or Bakor 230-39 or polymer waterproof adhesive and finish and seal the complete assembly with Foster 60-38 or Bakor 130-11 or polymer to form an unbroken vapour barrier.
- .4 Reinstall or readjust any hanger or support which has been moved in any way to carry out the above work.

3.3 Equipment Drain Lines

- .1 Insulate flanges, valves, and fittings with segments of insulation of the same type and thickness as the insulation on the pipe, secured in place with soft annealed galvanized wire. Finish with Partek Hilcote insulating and finishing cement, and cotton wrapping applied while the cement is still wet.

3.4 Surface Finishes

- .1 Cover exposed insulated piping, valves and fittings in Boiler Rooms, Mechanical Rooms, Equipment Rooms, and areas where vehicular traffic, etc. could damage the insulation, with 220 g/m² (6 oz.) canvas.
- .2 Do not apply canvas to elastomeric closed cell foam or neoprene insulation, and piping which will be concealed or furred in.
- .3 Securely paste canvas on with a two coat application of Foster 30-36 or Bakor 120-18 fire resistive lagging adhesive over the entire surface. Apply canvas between coats of adhesive, while first coat is still wet. Stretch canvas tight and smooth with overlapping seams located where least visible. Apply second coat of adhesive immediately following application of canvas. Do not use metal bands.
- .4 Finish piping, valves and fittings indoors and outdoors insulated with elastomeric closed cell foam or neoprene with a full coating of white acrylic latex as recommended by insulation manufacturer.
- .5 Finish all other insulated piping installed outdoors with a field or factory applied metal jacket of 0.4 mm (26 ga.) aluminum, with longitudinal "snap-lock" or lapped joints and caulked and strapped butt joints secured with sheetmetal screws. Alternatively, finish pipe and fittings with glass fabric and Foster 65-07 or Bakor 110-26 or polymer fire resistive mastic as previously specified. Locate longitudinal joints in the bottom sector of horizontal lines and with laps positioned to shed any moisture.
- .6 On single ply roofs extreme care must be taken when applying mastic sealers to piping to ensure that no surplus mastic material remains in contact with the roof membrane. Any accidental spills must be cleaned up immediately. Provide temporary plastic drop sheets to protect roof around work area. Remove drop sheets on completion and clean-up of insulation work.
- .7 Seal canvas with off-white sizing to leave a smooth non-porous surface ready to receive paint application.

Thermal Insulation for Piping

- .8 Finish exposed insulated piping within 2.4 m of finished floor level of clean process areas with an exterior metal jacket of 0.4 mm (26 ga.) aluminum, with longitudinal "snap-lock" joints and strapped butt joints. Conceal longitudinal joints from view. The metal jacket may be field or factory applied.

END OF SECTION

Ductwork Insulation

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Related Sections

- .1 Ductwork – Low pressure metallic to 500 PA. Section 23 31 14

1.3 Submittals

- .1 Shop Drawings: Before ordering any insulating materials, submit to the Consultant a list of proposed insulation materials, exterior jackets and adhesive for the various services and equipment on the project. Deviation from the approved list will not be allowed.
- .2 Samples: Before ordering any insulation materials, prepare a sample board with a cross-section sample of all types of insulation, including exterior jacket, properly identified for the various services and equipment on the project and state types of adhesives used. Submit the sample board to the Consultant for his review and, after review and acceptance, the sample board will be kept in the Consultant's site office for the duration of the project for reference. Deviation from the accepted samples will not be allowed.

PART 2 - PRODUCTS

2.1 Insulation on Sheetmetal

- .1 Apply insulation to the following ductwork systems and components:
- .2 Insulate 1800 mm from outlet (louvre, roof cap or roof exhauster) of exhasut ductwork with flexible duct insulation of 12 kg/m³ (3/4 lb/cu.ft.) density, 25 mm (1") thickness, with reinforced foil flame resistant kraft facing.

2.2 Fire and Smoke Rating

- .1 In accordance with CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.3 Jackets

- .1 Aluminum:
 - .1 To ASTM B209 without moisture barrier as scheduled in PART 3 of this section.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: Smooth.

Ductwork Insulation

- .4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

2.4 Acceptable Products

Manson	Alley Wrap FSK
FibreX Insulations Inc.	FibreX IF Flex 1230 FSK
Knauf Fibre Glass	Blanket Insulation with FSK Facing
Johns Manville	Duct Wrap Type 150 Micolite

PART 3 - EXECUTION

3.1 General

- .1 Perform insulation work using qualified insulation applicators, in accordance with latest trade application methods and to the Consultant's approval.
- .2 Clean all surfaces to be insulated to remove grime, grease, oil, moisture or other matter to ensure that insulation is applied to clean dry surfaces.
- .3 Apply insulation under ambient temperature conditions in accordance with insulation or adhesive manufacturer's recommendations.
- .4 Do not apply insulation until ductwork has been tested, inspected, verified, and accepted by the Consultant.
- .5 Apply insulation neatly and tightly in unbroken lengths and with ends of sections firmly and squarely butted or engaged together. Lap canvas or other specified wrapping over all joints and thoroughly cement down with adhesive. Extend insulation through sleeves in walls (except fire walls) or other openings in building to make insulation and vapour barrier continuous and of uniform diameter.
- .6 Where asbestos-containing insulation has been removed from existing ductwork, reinsulate (to same extent as removal work) or (to extent as indicated on Drawings). Maintain same thermal value as existing.
- .7 Terminate insulation at each side of fire walls and pack the space between wall sleeve and duct or pipe as specified in Section 23 05 00.
- .8 Replace insulation removed from existing ductwork to make tie-in connections with new insulation. Cut back existing insulation a sufficient distance to make a neat and firm butt joint between old and new insulation.

3.2 Sheetmetal

- .1 Secure insulation on exposed rectangular ductwork with welded impaling pins and speed washer type fasteners at 300 mm (12") centres. Provide a minimum of two rows of fasteners on each side of duct.

Ductwork Insulation

- .2 In addition to mechanical fasteners, adhere insulation to the duct with Foster 85-20 or Bakor 230-38 fire resistive adhesive applied to the duct in 150 mm (6") wide strips at 450 mm (18") centres. Tightly butt all joints and breaks in insulation and seal with Foster 30-35 or Bakor 130-11 fire resistive mastic and 75 mm (3") wide scrim foil pressure sensitive tape. Cut off protruding ends of welded pins and cover speed washers with same tape to ensure a smooth application of exterior jacket.
- .3 Fasten insulation to concealed rectangular ductwork and to both concealed and exposed round ductwork with Foster 85-20 or Bakor 230-38 adhesive, applied in 150 mm (6") wide strips at 300 mm (12") centres. Tightly butt all edges and joints and seal with Foster 30-35 or Bakor 130-11 fire resistive mastic and 75 mm (3") wide pressure sensitive scrim foil tape. Use tying cord only to temporarily secure insulation until adhesive has set. Remove prior to application of exterior jacket.
- .4 Insulate access doors or removable panels in ductwork as separate units to permit opening or removal without damage to adjoining insulation.

3.3 Ductwork Insulation Schedule

- .1 Insulation types and thicknesses: Conform to following table:

	TIAC Code	Vapour Retarder	Thickness (mm)
Exhaust duct for 1800 mm from outlet of exhaust fan and energy recovery ventilators	C-1	Yes	25 mm (flexible)
Energy Recovery Ventilators fresh air duct from inlet	C-1	Yes	50 mm (rigid)
Energy recovery ventilators supply air duct	C-1	Yes	25 mm

END OF SECTION

Start-Up & Performance Testing

PART 1 - GENERAL**1.1 Summary****.1 Section Includes**

- .1 Labour, products, equipment and services necessary to complete the work of this Section.
- .2 Section includes, but is not necessarily limited to, the following:
 - .1 Performance testing and balancing of heating, ventilating, air conditioning and liquid systems
 - .2 Survey of installed automatic controls and verification of functional performance
 - .3 Rechecking of testing and balancing during the alternate (heating/cooling) season

1.2 Related Work In Other Sections

- .1 Factory testing, and calibrating of equipment or control systems.
- .2 Testing and checking of equipment supplied by other Divisions, except where such equipment forms an integral part of the mechanical systems.

1.3 Coordination

- .1 The General Contractor through the Mechanical Contractor and/or associated sub-contractors will provide the following assistance and/or services to the Testing and Balancing firm.

Schedule sufficient time so that initial testing and balancing can be completed before occupancy begins and coordinate with trades involved.

Keep Testing and Balancing firm informed of any major changes made during construction and furnish same with a set of project drawings and reviewed Shop Drawings.

Furnish balancing devices, test connections access openings, balancing probe inlets and plugs.

Clean and pre-run all equipment, filters, etc. and place all heating, ventilating and air conditioning systems into full operation and continue same during each working day of testing and balancing.

Provide immediate labour from pertinent mechanical trades and tools, equipment and materials to make equipment and system alterations and adjustments, as required including control adjustments.

Building Management System technical representative to operate the BMS during air and water balancing testing.

Make available all equipment data (Shop Drawing Performance Data and operating instructions) to the Testing and Balancing Firm.

Start-Up & Performance Testing

Refrigeration machine manufacturer service representative for performance testing of the refrigeration equipment. Testing and Balancing Firm witnesses and records all test results.

Fuel fired heating equipment manufacturer service representative, or other qualified service company technical representative, for performance testing of heating equipment. Testing and Balancing Firm witnesses and records all test results.

- .2 As part of the coordination effort, the General Contractor through the Mechanical Contractor will be fully responsible for systems constructed, installed and adjusted to provide optimum performance as required by design intent. Any re-adjusting required as the result of spot checks by the Consultant shall be done at no increase in Contract Price.

1.4 Submittals

- .1 Submit in accordance with Section 01 33 00.
- .2 Submit layout drawings and report format a minimum 14 days prior to start of air and water balancing on-site.
 - .1 Report format
 - .1 Submit proposed format of initial report.
 - .2 Include a complete list of instruments and tests for which they are to be used as they relate to this project, including date of last calibration

PART 2 - PRODUCTS

2.1 Not Applicable

PART 3 - EXECUTION

3.1 Required Reports

- .1 Provide the following Start-Up and Performance Testing reports:
 - .1 Equipment start-up report
 - .2 Authorities report
 - .3 Air and water balancing report
 - .4 Controls/BMS operation report
 - .5 Alternate season test report
- .2 Report Format
 - .1 Prepare test forms in MS Excel or Word format. Results of tests may be filled in by hand.
 - .2 Include the following header information for each test report:
 - .1 Owner Name
 - .2 Project Name

Start-Up & Performance Testing

- .3 Contractor Name
- .4 Consultant Name
- .5 Name of Test Report
- .3 Include the following on the front sheet of the consolidated report:
 - .1 Contractor Company Name
 - .2 Name and signature of the person submitting the report
 - .3 Date of report
- .3 Submit the above tests in a hardcopy form, separately bound from the Operations and Maintenance manuals, and in Adobe Acrobat PDF format, in accordance with Section 01 33 00.

3.2 Equipment Start-Up Report

- .1 Provide a consolidated test report for all equipment, including the following start-up tests:
 - .1 Equipment/System summary tests
 - .2 Equipment/System start-up test.
 - .3 Manufacturer to sign off on start-up reports
- .2 Equipment/System Summary Tests
 - .1 Provide a test report in spreadsheet format which summarizes the following data for each piece of equipment which is powered or has automatic controls:
 - .1 Equipment ID and name
 - .2 Motor insulation megger test - result and initialled by contractor
 - .3 Motor rotation (bump test) - result and initialed by contractor
 - .4 Equipment Start-Up report status - status and initialed by contractor
 - .5 Manufacturer Start-Up report status - status and initialed by contractor
 - .6 Test completion date
 - .2 Provide a test report in spreadsheet format which summarizes the following data for pressure testing of piping systems:
 - .1 System name
 - .2 System limits (if system is not tested in its entirety)
 - .3 Type of test (pneumatic, hydrostatic)
 - .4 Pressure at start of test
 - .5 Pressure at end of test
 - .6 Duration of test
 - .7 Contractor dated and initialed.

Start-Up & Performance Testing

- .3 Provide a test report in spreadsheet format which summarizes the following tests for equipment served by liquid, gas or vapor systems
 - .1 Equipment ID and name
 - .2 Isolation valves are in the open position - status and initialed by contractor
 - .3 Backflow preventers have been tested - status and initialed by contractor
 - .4 Pressure relief valves installed - record setpoint and initialed by contractor
- .3 Equipment/System Start-Up Test Report
 - .1 Provide a separate start-up report for each piece of the following equipment. The SMACNA "Systems Ready to Balance Check List", where applicable, may be used for this report.
 - .1 Heat Pump Units
 - .2 Duct systems
 - .3 Pumps
 - .4 Snow Melting System
 - .5 Hydronic piping systems
 - .6 Evaporative Water Cooler
 - .7 Energy Recovery Ventilators
- .4 Manufacturer's Start-Up Test
 - .1 Provide a separate start-up report for each piece of the following equipment, utilizing the manufacturer's start-up check list. This report may be prepared by the manufacturer's service representative.
 - .1 Heat Pump Units
 - .2 Snow Melting System
 - .3 Domestic hot water heaters
 - .4 Control Systems
 - .5 Heat Recovery Ventilators

3.3 Authorities Review

- .1 Submit copies of authorities-having-jurisdiction inspection and test reports, including:
 - .1 Plumbing and drainage municipal inspector reports
 - .2 TSSA pressure vessel and piping inspection reports
 - .3 ESA field certification reports

Start-Up & Performance Testing

3.4 Air and Water Balancing

- .1 Provide air and water balancing report: to Section 23 05 93.

3.5 Controls/Building Management System

- .1 Provide controls test reports: to Section 25 90 00.

3.6 Alternate Season Testing

- .1 Provide alternate season test report: to Section 25 01 11.

3.7 Deficiencies

- .1 Immediately report to Consultant, any deficiencies in the systems or equipment performance resulting in design requirements being unobtainable.

3.8 Draft Report

- .1 On completion of the start-up, testing, adjusting and balancing of all systems, submit to the Consultant, two (2) typewritten copies of a full report on all tests, adjustments, and balancing performed, including the following:
 - .1 Summary of all systems
 - .2 Testing methods and instrumentation
 - .3 Start-up reports
 - .4 Authorities having jurisdiction reports
 - .5 Air systems testing and balancing data
 - .6 Liquid systems testing and balancing data
 - .7 Attachments including systems schematics with numbered terminals for referring to data above.
- .2 After review by the Consultant and at the Consultants direction, retest up to 10% of all measurements in locations as directed by the Consultant, at no cost extra to the contract.

3.9 Interim Report

- .1 After completion of any retesting described above, submit three (3) typewritten copies of the interim report, in a 3-hole "D" style binder, and two (2) CD-R electronic copy in Adobe Acrobat ver.6 PDF format.
- .2 This report is required to obtain Substantial Performance of the Contract.

Start-Up & Performance Testing

3.10 Final Report

- .1 Submit to Consultant following completion of alternate season testing and balancing. Submit three (3) typewritten copies and two (2) CD-R Adobe PDF in the same formats as the initial report specified above.

3.11 Spot Checks

- .1 Before acceptance of the air and water balancing report, the Consultant may request to witness spot-checks of the report results.
- .2 If results indicate unusual testing inaccuracy, omissions, or incomplete balancing/adjustment, in the opinion of the Consultant, re-balance entire affected system(s) at no increase in Contract Price.

3.12 Acceptance

- .1 The Substantial Performance of the Mechanical Work will be considered reached when the interim Start-Up and Performance Testing report is accepted by the Consultant and in the opinion of the Consultant all systems have been satisfactorily installed, operated tested, balanced, and adjusted to meet the specified and intended performance.
- .2 The substantial performance will not depend upon alternate season testing as specified hereafter, however, make such relevant repairs or modifications deemed necessary during this re-checking as part of the guarantee of the work.
- .3 The total performance of the Mechanical Subcontract (Contract) will not be considered reached until the alternate season testing and balancing is completed and the final report submitted and accepted by the Consultant.

3.13 Additional Testing

- .1 The Consultant may request such additional testing in connection with this project as he deems necessary.

END OF SECTION

Project Close-Out

PART 1 - GENERAL

1.1 Summary

- .1 Section Includes
 - .1 Labour, products, equipment and services necessary to complete the work of this Section.

1.2 Substantial Performance

- .1 Complete the Substantial Performance Checklist and submit with required documentation when applying for Substantial Performance of the Work.
 - .1 Where the work is sub-divided into separate scopes of Work, each requiring a separate Substantial Performance application, provide a separate checklist for each application.
- .2 Prepare and submit to the Consultant a comprehensive deficiency list of items to be completed or corrected, as part of the application for a review by the Consultant to establish Substantial Performance of the Work, or designated portion of the Work.
 - .1 Failure to include an item on the list does not alter the Contractor's responsibility to complete the Work.
- .3 Within five working days of the Consultant's review report which indicates that Substantial Performance of the Work has been achieved, provide a detailed schedule for completion and/or correction of the Work of all items described in the Contractors' and the Consultants' deficiency list.

1.3 Total Performance

- .1 Complete the Total Performance Checklist and submit required documentation when applying for Substantial Performance of the Work.
- .2 Submit the following documentation with the application for Total Performance. Application for Total Performance cannot be submitted any earlier than the date of Alternate Season testing.
- .3 The following documentation is included with this application for Total Performance, or, has already been submitted to the Owner and a copy of the transmittal is included with this application.

Project Close-Out

SUBSTANTIAL PERFORMANCE APPLICATION CHECKLIST

Project Information		
Project Name:		
Contract:		
Contract Scope:		
Application Date:		
Signed:		
Required Documentation		
No.	Item	Included
1.	Contractor has compiled and submitted a detailed deficiency list, identifying work still to be completed, incomplete, or requires correction.	
2.	Equipment start-up reports (Interim)	
3.	Authorities report (Interim)	
4.	Air and Water Balancing reports (Interim)	
5.	Controls / BMS operation report (Interim)	
6.	Operating and Maintenance Manuals, draft, submitted.	
7.	Training, completed	
8.	Commissioning Report – Verification and Training	
Reviewed by Consultant		
Status	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit	
Signed:		
Date:		

Project Close-Out

TOTAL PERFORMANCE APPLICATION CHECKLIST

Project Information		
Project Name:		
Contract:		
Contract Scope:		
Application Date:		
Signed:		
Required Documentation		
No.	Item	Included
1.	Contractor submits a statutory declaration that all know deficiencies have been corrected, including latent deficiencies reported by the Owner.	
2.	Equipment start-up reports – updated and final	
3.	Authorities report – updated and final	
4.	Air and Water Balancing reports – updated and final	
5.	Controls / BMS operation report – updated and final	
6.	Operating and Maintenance Manuals – updated and final	
7.	As-Built drawings – final	
8.	Commissioning Report – Performance Testing	
Reviewed by Consultant		
Status	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit	
Signed:		
Date:		

END OF SECTION

Hydronic Specialties

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to General Mechanical Requirements Section 21 05 00 as applicable.
- .3 All components shall be compatible with ethylene glycol.

1.2 Related Sections

- .1 Piping insulation: **Section 23 07 13**, Thermal Insulation for Piping.
- .2 Testing, Adjusting, Balancing and Recording - Section 23 05 93

1.3 Submittals

- .1 Shop Drawings: Prepare and submit shop drawings for all equipment and systems covered by this Section in accordance with Section 01 33 00 Administrative Requirements.
- .2 Operational and Maintenance Data: Provide equipment literature, operating instructions, maintenance instructions, parts lists, and other pertinent data for all equipment and systems covered by this Section.

PART 2 - PRODUCTS

2.1 Pipe, Fittings and Valves

- .1 For types of pipe, fittings and valves for services in this Section refer to the following Piping Standards attached to Section 21 05 00.
Standard No. 006 Service Water Piping.

2.2 Strainers

- .1 "Y" type, Class 125 cast iron body strainer with removable monel screen and bolted cleanout plug on flanged strainers and screwed cleanout on screwed strainers. Provide screwed strainers for sizes NPS 2 and smaller and flanged strainers for sizes NPS 2-1/2 and larger.
- .2 "Y" type, Class 250 semi-steel body strainer with removable monel screen and bolted cleanout plug on flanged strainers and screwed cleanout on screwed strainers. Provide screwed strainers for sizes NPS 2 and smaller and flanged strainers for sizes NPS 2-1/2 and larger.
- .3 Provide strainers in equipment rooms and where shown in other locations, complete with NPS 3/4 blow-off globe valves.

Hydronic Specialties

- .4 Furnish screen with perforations as follows:

- Type of ServiceScreen Perforation (dia)

- H.W. Heating1.6 mm (1/16")

- .5 Acceptable Products

- Spirax Sarco

- Armstrong

- Streamflo

- Colton

2.3 Thermometers

- .1 The following Terice figure numbers indicate the required construction and other features.

- .2 Stem type thermometers: Terice BX9 series Industrial (230 mm) (9") scale, adjustable angle type, with red appearing mercury lens front tube, and cast aluminum case.

- .3 Dial type thermometers: Terice No. L80742 Series solid liquid filled, (114 mm) (4-1/2") dial size, universal angle type, with linear scale, black cast aluminum case, chrome plated ring, bronze bushed brass movement with adjustable pointer.

- .4 Select scale ranges to best suit the application and operating conditions, with graduations in both Fahrenheit and Celsius degrees for direct reading to 2F and 1C and an accuracy of 1% to 1-1/2%.

- .5 Provide sensing bulbs suitable for the medium being measured. Furnish bulbs in piping or equipment with stainless steel separable wells.

- .6 Approved Manufacturers:

- Terice

- Ashcroft

- Weiss

- Weksler

- Approved Alternate

2.4 Air Vents

- .1 Approved Manufacturers

- Maid-O-Mist No.7

- Taco Hy-Vent

- Braukmann EA122

- Spirax Saveo 13WS

- Approved Alternate

Hydronic Specialties

2.5 Drain Valves

- .1 Provide (13 mm) (1/2") brass sediment faucets with hose thread outlets.
- .2 Approved Manufacturers
 - Crane
 - Emco
 - Cambridge Brass
 - Approved Alternate

2.6 Flexible Piping Connections

- .1 Furnish flexible metal hoses on the piping connections to heating and cooling coils, on the suction and discharge connections to pumps, and in piping systems where shown on the Drawings.
- .2 At coils provide Flexonics RW-81 or RW-91 hoses suitable for a minimum working pressure of (1034 kPa) (150 psig).
- .3 Furnish flexible hoses up to NPS 2 of braided bronze construction with screwed ends and union nut and nipple. Hoses NPS 2-1/2 and over to be braided stainless steel construction with Class 150 flanges. Furnish the standard hose length for normal industrial vibration.
- .4 At pumps provide Flexonics Model BBN hoses up to NPS 2 and BSF on piping NPS 2-1/2 and larger.
- .5 Approved Manufacturers
 - .1 Flexonics
 - .2 Piping Accessories of Canada
 - .3 Goodridge
 - .4 Approved Alternate

2.7 Diaphragm Type Expansion Tank

- .1 Horizontal galvanized steel pressurized diaphragm type expansion tank.
- .2 Capacity 38 L.
- .3 Size as indicated.
- .4 Diaphragm sealed in elastomer suitable for 115 degrees C operating temperature.
- .5 Working pressure 860 kPa with ASME stamp and certification.
- .6 Air precharged to 84 kPa (initial fill pressure of system).
- .7 Saddles for horizontal installation.
- .8 Alternate Equipment: Amtrol, Expanflex, Bell & Gossett

Hydronic Specialties

2.8 Air Separator – In-Line

- .1 Working pressure 860 kPa.
- .2 Size NPS 1 ½.
- .3 Alternate Equipment: Armstrong, ITT, Taco

2.9 Combination Low Pressure Relief and Reducing Valve

- .1 Adjustable pressure setting 206 kPa relief, 55 kPa.
- .2 Low inlet pressure check valve.
- .3 Removable strainer.
- .4 Alternate Equipment: Danfoss, Armstrong, Tyco

2.10 Flow Measuring Equipment

- .1 Fittings up to 50 mm size shall be screwed end circuit balancing fitting with shutoff/balancing valve, drain connection and meter connections. Fittings over 50 mm size shall be flanged end circuit balancing fitting with valved meter connection and shutoff/balancing valve. Fittings shall be rated for 862 kPa working pressure.
- .2 Provide one (1) portable flow measuring device c/w carrying case, fittings, connections and pre-calibrated.
- .3 Alternate Equipment:
 - .1 Taco
 - .2 Delta 'P' (Air Power Equipment)
 - .3 Armstrong

PART 3 - EXECUTION**3.1 General**

- .1 Applicable requirements specified in Section 210501 form a part of this Section to the same extent as if stated herein in full.
- .2 Supply and install all miscellaneous structural supports, platforms, braces and tie-rods as may be required to hang or support all equipment, piping, etc., installed under this Section, in accordance with the drawings and/or as directed by the Consultant.

3.2 Gauges, Thermometers and Temperature Immersion Wells

- .1 Install pressure gauges and thermometers in all locations shown on drawings or specified. Mount gauges not higher than (2.5 m) (8'-0") from the floor or operating platform.

Hydronic Specialties

- .2 Install gauges and thermometers as recommended by the manufacturer. Provide isolating petcocks on all pressure gauges.
- .3 Fill immersion wells with a high temperature mineral grease prior to insertion of thermal bulb.
- .4 Install immersion wells so they do not restrict the flow of liquids in piping. Increase size of piping as required to prevent restriction.

3.3 Drain Valves

- .1 Install drain valves at low points of water systems in order to completely drain each system, and also in any other location noted on Drawings.

3.4 Flexible Pipe Connections

- .1 Install flexible metal hoses in piping systems where indicated on Drawings.
- .2 Firmly supply or guide piping adjacent to flexible connection to prevent pipes from swaying.

3.5 Air Vents

- .1 Install automatic air vents at high points of glycol piping systems and also in any other location noted on Drawings.
- .2 Install automatic air vents with 150 mm (6") high, line size or NPS 4 size air pocket, whichever is smaller, and NPS $\frac{3}{4}$ isolating gate valve and piping to inlet connection of air vent.
- .3 Connect discharge to nearest funnel or hub drain or as shown on Drawings.
- .4 Provide manual air vent in locations noted on Drawings.

3.6 Pressure Safety Relief Valves

- .1 Run discharge pipe to terminate above nearest drain.

3.7 Expansion Tank

- .1 Adjust expansion tank pressure to suit design criteria.
- .2 Install lock shield type valve at inlet to tank.

END OF SECTION

Hydronic Systems, Steel

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Related Sections

- .1 Section 21 05 00 "General Mechanical Requirements"
- .2 Section 23 05 29 "Pipe Hangers and Supports"
- .3 Section 23 05 23 "Valves"
- .4 Section 23 21 14 "Hydronic Specialties"
- .5 Section 23 05 54 "Mechanical Identification"

1.3 Submittals

- .1 Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
- .2 Welding Certificates: Copies of certificates for welding procedures and personnel.
- .3 Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
 - .1 Test procedures used.
 - .2 Test results that comply with requirements.
 - .3 Failed test results and corrective action taken to achieve requirements.

1.4 Quality Assurance

- .1 Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- .2 ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

1.5 Coordination

- .1 Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, fire-suppression-system components, and partition assemblies.
- .2 Coordinate pipe sleeve installations for foundation wall penetrations.

Hydronic Systems, Steel

- .3 Coordinate pipe fitting pressure classes with products specified in related Sections.
- .4 Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.
- .5 Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Through-Penetration Firestop Systems" for fire and smoke wall and floor assemblies.

PART 2 - PRODUCTS

2.1 Manufacturers

- .1 Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- .2 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - .1 Grooved Mechanical-Joint Fittings and Couplings:
 1. Central Sprinkler Company; Central Grooved Piping Products.
 2. Grinnell Corporation.
 3. Victaulic Company of Canada.
 4. Approved Alternate
 - .2 Calibrated Balancing Valves:
 1. Armstrong Pumps, Inc.
 2. ITT Bell & Gossett; ITT Fluid Technology Corp.
 3. Taco, Inc.
 4. Approved Alternate

2.2 Piping Materials

- .1 General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 Steel Pipe and Fittings

- .1 Steel Pipe, NPS 2 and Smaller: ASTM A 53, Type S (seamless) or Type F (furnace-butt welded), Grade B, Schedule 40, black steel, plain ends.
- .2 Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.
- .3 Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- .4 Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.

Hydronic Systems, Steel

- .5 Grooved Mechanical-Joint Fittings (sprinklers only): ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47, Grade 32510 malleable iron; ASTM A 53, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.
- .6 Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.
- .7 Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
- .8 Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.
- .9 Victaulic fittings may be used.

2.4 Valves

- .1 Gate, globe, check, ball, and butterfly valves are specified in Division 15 Section "Valves."
- .2 Calibrated Balancing Valves, NPS 2 and Smaller: Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.

2.5 Refrigerant Piping

- .1 ACR hard copper with wrought copper fittings.
- .2 Joints shall be made with lead-free solder 95/5.
- .3 Vibration isolator on each pipe to DX coil and condensing unit.
- .4 R410A refrigerant or latest approved type.
- .5 All welded joints to be completed using continuous nitrogen flush.
- .6 Thermal expansion valve and solenoid valve for each circuit.
- .7 Pressure gauge connection on inlet to each compressor, condenser and evaporative coil.
- .8 Drain pipe of Type 'M' hard copper with solder fittings for each fan coil unit.

PART 3 - EXECUTION

3.1 Piping Applications

- .1 Hot Water, NPS 2 and Smaller: Aboveground, use Schedule 40 steel pipe with threaded joints.
- .2 Condensate Drain Lines: Schedule 40.

Hydronic Systems, Steel

3.2 Valve Applications

- .1 General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
 - .1 Shutoff Duty: Ball, and butterfly valves.
 - .2 Throttling Duty: Globe, ball, and butterfly valves.
- .2 Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
- .3 Install calibrated balancing valves in the return water line of each heating element and elsewhere as required to facilitate system balancing.

3.3 Piping Installations

- .1 Refer to Division 210501 Section "General Mechanical Requirements" for basic piping installation requirements.
- .2 Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- .3 Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- .4 Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- .5 Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- .6 Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.

3.4 Field Quality Control

- .1 Prepare hydronic piping according to ASME B31.9 and as follows:
 - .1 Leave joints, including welds, uninsulated and exposed for examination during test.
 - .2 Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - .3 Flush system with clean water. Clean strainers. Clean system prior to filling.
 - .4 Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

Hydronic Systems, Steel

- .2 Perform the following tests on hydronic piping:
 - .1 Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - .2 While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
 - .3 Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
 - .4 After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 - .5 Prepare written report of testing.

3.5 Cleaning

- .1 On completion, clean complete heating using Dearborn #11 or equal cleaner for at least 48 hours at 20oF. Flush out each system, opening and cleaning each scale pocket and strainer. System must be flushed out before filling with clean water and Dearborn #545 molybdate corrosion inhibitor at 90 ppm.
- .2 Provide written report to Consultant when cleaning is completed. Advise Consultant at least 48 hours prior to cleanout so same can be witnessed.
- .3 The supplier of the chemical treatment equipment and chemicals will supervise the entire cleaning and flushing operation of all the systems.
- .4 The supplier shall ensure the following:
 - .1 All systems are flushed of all sand, gravel and fillings before cleaner is added.
 - .2 The proper strength of cleaner is added and circulated for the prescribed time.
 - .3 Each system is thoroughly flushed again before chemicals are added.
 - .4 The proper dosage of chemicals is added.
 - .5 Cartridge filters are replaced at the proper intervals.
- .5 Provide written report to Consultant when cleaning is completed. Advise Consultant at least 48 hours prior to cleanout so same can be witnessed.
- .6 Acceptable Products:
 - .1 Drew Chemical Co.
 - .2 Finnan Eng. Products Ltd.

Hydronic Systems, Steel

3.6 Refrigerant Piping

- .1 After completion of refrigeration piping installation, test each piping system under nitrogen for leaks. Repair any leaks detected. Evacuate each system three times by vacuum pump to 508 mm Hg. Each system shall hold same for 24 hours without decrease in vacuum. Upon completion of testing and dehydration process, each system shall be charged with refrigerant. Halo Carbon inventor forms shall be completed.
- .2 Provide all wiring necessary to complete each system including controls and inter-wiring to condenser units and DX coil solenoid valves and hot gas bypass controls.
- .3 Provide complete start-up service and instruct Building Operators in care and maintenance of DX type Air Conditioning System. See 210501 – General Mechanical Requirements – Instructions to Operator.

END OF SECTION

HVAC Pumps

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to General Mechanical Requirements Section 21 05 00 as applicable.

1.2 Related Sections

- ~~.1 Vibration isolation: Section 23 05 48.~~
- .2 Building Management System: Section 25 90 00.**
- .3 Sequence of Operation: Section 25 90 01
- .4 Electrical Wires and Cables: Section 26 05 00.**

1.3 Submittals

- .1 Shop Drawings
 - .1 Prepare and submit complete shop drawings in accordance with Section 01 30 00 Administrative Requirements.
 - .2 Indicate equipment including connections, fittings, control assemblies and ancillaries, and identify factory and field assemblies.
- .2 Maintenance Data
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 33 00 Administrative Requirements.

PART 2 - PRODUCTS

2.1 VERTICAL INLINE PUMPS

- .1 Furnish low temperature water pumps of capacity, size, and electrical characteristics indicated on Drawings.
- .2 Furnish "in-line" type circulators with oval or round flanges matching threaded companion flanges and direct connected through a flexible connection to motor.
- .3 Furnish all-bronze construction circulators, with alloy steel shaft, oil-lubricated bronze sleeve bearings, and mechanical seal.

HVAC Pumps

- .4 Each vertical inline pump shall be Armstrong Series 4300, Split Coupled Type Vertical In-Line Centrifugal pumping unit. The pumps shall be radially split, single stage centrifugal type with BF (Bronze Fitted) casing with equal size suction and discharge flanges and having separate tapped flush line and pressure gauge connections, Bronze dynamically balanced impeller, stainless steel shaft, lower carbon throttle bushing, Outside balanced type mechanical seal with Carbon rotating face, Ceramic stationary seat and Viton secondary seal. Motor shall be inverter type suitable for usage with VFD. Motor shall be inverter type suitable for usage with VFD.

The pump is to be fitted with a factory installed flush line. Supply in the flush line to the mechanical seal, a 50 micron cartridge filter (alternatively, a cyclone separator when pump differential pressure exceeds 30 PSIG) and floating ball type sight flow indicator suitable for the working pressure encountered. The mechanical contractor shall change the filters after the system has been flushed and on a regular basis until the pumps are turned over to the owner. The squirrel cage induction type, P-base, with ODP enclosure and shall be connected to the pump through a high tensile aluminum, split type spacer coupling to permit Servicing of the mechanical seal without disturbing pump, motor or electrical wiring. Coupling shall be protected by a guard.

- .5 Acceptable Manufacturers
- .1 S.A. Armstrong
 - .2 Taco
 - .3 ITT
 - .4 Approved Alternate

PART 3 - EXECUTION

3.1 General

- .1 Install work of this Section to applicable requirements of Section 21 05 00.

3.2 Pump Installation

- .1 Set pumps in place, align, connect and place in operation with:
- .2 Controls set for efficient, stable operation.
- .3 Connections and required safety devices installed.
- .4 Protect pumps from damage during and after installation, and on completion of work ensure that equipment is free from cracks, scratches, discolorations, tool marks, and other defects. Thoroughly clean finished surfaces before acceptance of work.
- .5 Support pumps independent of piping such that no loads are transmitted to pumps.
- .6 Provide suction diffuser and triple duty valve for each vertical inline pump.

END OF SECTION

HVAC Water Treatment

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to General Mechanical Requirements: Section 21 05 00 as applicable.
- .3 All components shall be compatible with ethylene glycol.

1.2 Related Sections

- .1 Piping insulation: **Section 23 07 13**, Thermal Insulation for Piping.
- .2 Testing, Adjusting, Balancing and Recording - Section 23 05 93

1.3 Submittals

- .1 Shop Drawings
 - .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Operation and Maintenance Data
 - .1 Submit printed operation instructions and maintenance data in accordance with Section 01 78 23.
 - .2 Submit information for incorporation in operating manual for each internal water treatment system. Include schematic drawings, data sheets for equipment, and step by step instructions for testing procedures.

PART 2 - PRODUCTS

2.1 Outline Description

- .1 General
 - .1 Provide packaged chemical control systems as described herein.
 - .2 Systems to be complete with chemical drums, pre-mixed chemical solutions
 - .3 Acceptable Manufacturers:
 - .1 Rochester Midland Corp. (RMC)
 - .2 WMC
 - .3 Guardian Chemicals
 - .4 Glengarry Chemicals
 - .5 General Filtration Chemicals Co.
 - .6 Approved Alternate

HVAC Water Treatment

2.2 Snow Melting and Heat Pump Systems

.1 Heat Pump Loop Water Treatment

.1 Corrosion control equipment and chemicals are required for each of following closed circuit cooling systems:

.2 System Data:

Type of System:	Closed Recirculating /
Recirculation Rate, L/s	18.9
Temperature Range:	12°C to 35°C
Estimated System Volume, Litres	2000
Chemical System Type	Pot Feeder

.3 Provide equipment for EACH of above noted systems.

.2 Snow Melting System Water Treatment

.1 Corrosion control equipment and chemicals are required for each of following closed circuit cooling systems:

.2 System Data:

Type of System:	Closed Recirculating /
Recirculation Rate, L/s	1.89
Temperature Range:	60°C to 88°C
Estimated System Volume, Litres	300
Chemical System Type	Pot Feeder

.3 Provide equipment for EACH of above noted systems.

.3 Chemical System Type

.1 Pot feeders:

- .1 45 litre capacity, cast steel
- .2 Working pressure: 550 kPa
- .3 Working temperature: 55°C
- .4 Fitted with cartridge type filter for filtrate quality of 20 microns
Sized to handle 5% of pump capacity

.4 Supply following chemicals in addition to those used for cleaning systems:

- .1 Cleaner - for each Recirculating System, two 23 Litre Pails of CSW.

HVAC Water Treatment

- .2 Chemical for Closed Systems
 - Five 20 litre pails of nitrite corrosion control chemicals.
 - Drew Type `S' Test Cabinet with light and lock.
 - Nitrite Test Kit (#2508)

PART 3 - EXECUTION

3.1 Manufacturer's Instructions

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 Installation

- .1 Install HVAC water treatment systems in accordance with ASME Boiler Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.
- .2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

3.3 Chemical Feed Piping

- .1 Install crosses at changes in direction. Install plugs in unused connections.

3.4 Cleaning & Flushing of Mechanical System

- .1 On completion, clean complete H.T and heat pump system using Ferroquest 345 or equal cleaner for at least eight hours at 37.8oC. Flush out each system, opening and cleaning each scale pocket and strainer. System must be flushed out before filling with clean water.
- .2 If in-line circulators are used during cleaning and flushing, provide new seals on same afterwards. Ensure flushing line on base mounted pump seals are operating during cleaning flushing, when pumps are on. Division 15 shall replace all pump seals which become defective during the one year guarantee period, at NO COST to Owner.
- .3 During cleaning operation, heat pump units shall be disconnected and their hose connections used to bypass water around each unit. Operate heating boilers to maintain 30oC system water temperature in systems. DO NOT EXCEED 43oC. See heat pump manufacturers printed instructions for further information and guidance.
- .4 Install evaporative water cooler treatment system as described providing piping, valves, supports and accessories not supplied by manufacturer. Arrange for start-up, instruction period and put system in proper, safe, efficient operating condition.
- .5 The supplier of the chemical treatment equipment and chemicals will supervise the entire cleaning and flushing operation of all the systems.

HVAC Water Treatment

- .6 The supplier shall ensure the following:
 - .1 All systems are flushed of all sand, gravel and filings before cleaner is added.
 - .2 The proper strength of cleaner is added and circulated for the prescribed time.
 - .3 Each system is thoroughly flushed again before chemicals are added.
 - .4 The proper dosage of chemicals is added.
 - .5 Cartridge filters are replaced at the proper intervals.

- .7 Provide written report to Consultant when cleaning is completed. Advise Consultant and Owner at least 48 hours prior to cleanout so same can be witnessed.

END OF SECTION

Sound Absorbers

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Related Sections

- .1 Section 23 05 54: Mechanical Identification
- .2 Section 23 31 14: Ductwork

PART 2 - PRODUCTS

2.1 Sound Absorbers

- .1 Provide Burgess Vibro-Acoustics Ltd. duct silencers of sizes and types shown and noted in Silencer Schedule. Silencers shall meet operating conditions and dimensions scheduled.
- .2 Sound absorber supplier shall check and verify that silencers supplied will physically fit spaces allotted before fabrication of silencers and attached ductwork. Silencers shall be made to fit spaces and give performances shown.
- .3 Attenuations in decibels shall be "net insertion attenuation. Catalogued attenuations of alternate equipment shall NOT be less than two decibels below catalogued attenuations of specified silencers in all eight octave bands. Attenuations shall be certified by approved independent Testing Laboratory. When special units must be made to suit application, provide certification on actual units.
- .4 Noise reduction (NR) values specified shall be met or exceeded in each octave band noted. All NR values must be results of tests made in such manner to eliminate and reflections, beaming irectivity flanking standing waves and room absorptions.
- .5 Airflow Pressure drop values specified shall be met and pressure drop shall not be exceeded at specified airflows. Pressure drop ratings shall be based on results of tests made in manner to provide reliable data.
- .6 Materials of outer casings shall be not less than 22 gauge thick galvanized steel and interior partitions or splitters shall be not less than 22 gauge thick galvanized perforated steel.
- .7 Acoustical fill shall be inorganic glass or metal fiber of not less than 2.5# density which shall be packed behind partitions or splitters under not less than 10% compression to provide "spring" and avoid settling. Material shall be inert, vermin and moisture proof.

Sound Absorbers

- 8 Airtight construction shall be used and shall be leak-proof when subjected to differential air pressure of 8" of water gauge between outside and inside of noise reduction unit. Lock joints or seams shall be welded or filled with mastic as manufacturer elects.
- .9 Air passages shall be "Straight thru" and of relatively narrow unit dimensions.
- .10 Alternate Equipment:
 1. Vibron Ltd.
 2. Approved Alternate

PART 3 - EXECUTION

3.1 Sound Absorbers

- .1 Hang silencers from building structural with rod hangers independent from ducts.

END OF SECTION

Ductwork-Low Pressure Metallic to 500 PA

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Common Work Results – For Mechanical Section 21 05 00 as applicable.

1.2 Related Sections

- .1 Thermal Insulation for Ducting: Section 23 07 13.
- .2 Ductwork accessories: Section 23 33 00.

1.3 Submittals

- .1 Submit shop drawings in accordance with Section 01 33 00 Administrative Requirements.
- .2 Indicate design, construction and relevant details of sealant, tape and propriety joints.
- .3 See Sections 01 33 00 and 01 78 00.

PART 2 - PRODUCTS

2.1 Sheet Metal Work - General

- .1 Furnish sheet metal work in accordance with material specifications and construction details specified herein, and conforming to standard and recommended practices as defined by SMACNA Duct Construction Standards.
- .2 Furnish all ductwork constructed to SMACNA 2" w.g. pressure classification, unless noted otherwise on Drawings.
- .3 Furnish ductwork of galvanized steel sheet with Z-275 (G90) or ZF075 (A25) designation zinc coating to ASTM A653/A653M.
- .4 Furnish ducts of sizes shown on Drawings. For acoustically lined ducts, adjust duct size to accommodate liner thickness, with clear inside dimensions as shown on Drawings.
- .5 Fabricate ductwork free from vibration, rattle or drumming under operating conditions. Furnish necessary reinforcements, bracing, framing, gasketing, etc. to comply with performance criteria.
- .6 Continuously solder or seal joints in exterior air intake duct to prevent dripping of moisture through joints. Furnish 38 mm (1-1/2") drain flange in low point of such ductwork.
- .7 Furnish sleeves at duct penetrations through walls and floors, fabricated from same material and thickness sheet material as for ductwork. Furnish closure plates each side of wall to cover sleeve.

Ductwork-Low Pressure Metallic to 500 PA

- .8 Furnish flanged joints and gaskets of neoprene or other resilient non-flammable for duct connections to AC units, coils, etc. Fabricate flanges from mild steel angles to match equipment flanges.
- .9 Furnish screens of 13 mm (1/2") mesh x 2.7 mm (0.105") diameter galvanized wire for air intakes, exhausts and open ends of ductwork.
- .10 Rectangular Ductwork Type I - Low Pressure - Medium Pressure

- .1 Fabricate rectangular ductwork to metal thickness and construction methods as specified herein for various size ranges of ducts. Given dimensions represent widest side of duct.

Galvanized Steel Gauges and Equivalent Thicknesses

Gauge (gsg)	mm	Low Pressure	Medium Pressure	Slip
26	0.49 mm	Up to 300 mm		
24	0.64 mm	330 - 762 mm	Up to 457 mm	Up to 762 mm
22	0.84 mm	787 - 1372 mm	483-1219 mm	787-1524 mm
20	0.94 mm	1397-2134 mm	1245-1829 mm	1549 mm and over
18	1.24 mm	2134 mm and over	1854 mm and over	

- .11 Supports and Hangers - Rectangular Ductwork
 - .1 Except where shown otherwise on Drawings, Furnish strap hangers of 3 mm x 25 mm (1/8" x 1") mild steel bar stock for ducts up through 760 mm (30") width. Bend strap hanger around bottom of duct for a minimum of 38 mm (1-1/2") and attach to sides and bottom of duct. Furnish mild steel rod hangers of 10 mm (3/8") dia. minimum size for ducts over 760 mm (30") in width and furnish 38 mm x 38 mm x 3 mm (1-1/2" x 1-1/2" x 1/8") steel angle across bottom of duct and attach hanger to angle (not the duct).
- .12 Provide where shown, flexible air duct hoses. Secure hose to metal ducts with attachment screws and band clamps and tape seal with Permascreen fiberglass duct tape. Minimum length 25% longer than measured distance. Maximum length 50% more than measured length (max. 2 m). Provide manual balancing damper in trunk duct at connection to each flexible duct. Balancing dampers shall be opposed blades TAMCO 1000 c/w access door. Provide TAMCO 1000 dampers on all fresh air branch ducts connected to heat pumps or supplied to Classrooms.
- .13 Sound jacketing: provide Barymat BM-1C noise control composite around supply and return ducts from the equipment and all the way to the point the duct leaves or enters the Mechanical Room.

Ductwork-Low Pressure Metallic to 500 PA

2.2 Seal Classification

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C

.2 Seal classification:

- .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
- .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.
- .3 Class C: transverse joints and connections made air tight with sealant.
- .4 Unsealed seams and joints.

2.3 Sealant

- .1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.4 Tape

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.5 Duct Leakage

- .1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.6 Fittings

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows.
 - .1 Rectangular: standard radius short radius with single thickness turning vanes
Centreline radius: 1.5 times width of duct ____.
 - .2 Round: smooth radius five piece. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
 - .1 To 400 mm: with single double thickness turning vanes.
 - .2 Over 400 mm: with double thickness turning vanes.

Ductwork-Low Pressure Metallic to 500 PA

.4 Branches:

- .1 Rectangular main and branch: with radius on branch 1.5 times width of duct 45 degrees entry on branch.
- .2 Round main and branch: enter main duct at 45 degrees with conical connection.
- .3 Provide volume control damper in branch duct near connection to main duct.
- .4 Main duct branches: with splitter damper.

.5 Transitions:

- .1 Diverging: 20 degrees maximum included angle.
- .2 Converging: 30 degrees maximum included angle.

.6 Offsets:

- .1 Full short radiused elbows as indicated.

.7 Obstruction deflectors: maintain full cross-sectional area.

- .1 Maximum included angles: as for transitions.

2.7 Fire Stopping

- .1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Firestopping.
- .2 Fire stopping material and installation must not distort duct.

2.8 Galvanized Steel

- .1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

PART 3 - EXECUTION**3.1 Installation - General**

- .1 Refer to and comply with applicable requirements specified in Section 15010.
- .2 Install miscellaneous steel framing, supports, braces, etc. as may be required to hang or support ductwork as specified herein, and as shown on Drawings.
- .3 Install ductwork in arrangement shown on Drawings in accordance with standards and recommended practices off ASHRAE and SMACNA. Provide required offsets and transitions, whether specifically indicated or not, to facilitate duct arrangement and to avoid interference with building structure, piping, equipment and services.

Ductwork-Low Pressure Metallic to 500 PA

- .4 Install ductwork in locations and at elevations appropriate to ceiling height shown on Drawings. Where required to be concealed, install ductwork in furred spaces provided in walls and ceilings. Where there is no provision for concealed ductwork, install as close as possible to walls, partitions and overhead structures to attain maximum headroom and clearance.
- .5 Install sleeves where ducts pass through walls or floors. Pack space between duct and sleeve with mineral wool and seal both ends with non-inflammable fire resistant sealing compound. Install sheet metal closure plates on each side of wall to cover sleeve.
- .6 At air intakes, exhausts and open ends in ductwork install removable galvanized screens securely fastened in place.
- .7 Install gasketed flanged joints at duct connections to air conditioning units, coils, etc.
- .8 Install beam clamps or supplementary steel to secure hanger rods, angles and straps to structural steel framing.
- .9 Where shape of duct changes, install transition piece so that angle of side of transition piece does not exceed 15 degrees from straight run of duct being connected, unless shown otherwise on Drawings.
- .10 In office areas paint interior of ductwork for at least 600 mm (24") behind supply and exhaust grilles with matte black paint so as to render ductwork invisible from occupied space.
- .11 In areas having high humidity, slope exhaust ductwork up away from register and without seams in bottom of duct for at least 3 m (10'-0") of duct run behind register.
- .12 Slope fresh air intake ducts down at 1:100 to permit moisture induced by air intake to be drained. Install 38 mm (1-1/2") drain flange in bottom of duct at low point and run drain line to nearest floor drain or as noted on Drawings.

3.2 Supports and Hangers – Rectangular Ductwork

- .1 Install supports and hangers at intervals not over 2400mm (8'-0") centres for ducts up to 1500 mm (5'-0") in width and at 1200 mm (4'-0") centres for ducts 1500 mm (5'-0") in width and over.
- .2 Install miscellaneous steel angles or channels as required between joists or building steel for structural support of duct where building framing spacing does not coincide with the required hanger spacing.

3.3 Cleaning and Testing Of Ductwork

- .1 Inspect and test ductwork for air leakage at joints and connections to equipment, under normal operating conditions. Provide systems leakage tests to SMACNA Class 12 requirements.
- .2 Test ductwork before ducts are insulated, painted or concealed.
- .3 Immediately correct defects discovered during tests and retest systems to complete satisfaction of Consultant.

Ductwork-Low Pressure Metallic to 500 PA

- .4 Prior to start-up of fans, blow out complete systems of ductwork with high velocity air for not less than two hours using where possible the installed air handling equipment to full capacity and by blanking off duct sections to achieve required velocity. Do not install air filters prior to blow- out of ductwork systems. Use auxiliary portable blowers for cleaning where installed fan systems are not adequate to blow out complete system free from dust and dirt.
- .5 After duct systems have been blown out, clean register, grille or diffuser outlet collars with industrial type vacuum cleaner. On completion of cleaning process, install filters before placing systems in final operation.

3.4 Sealing and Taping

- .1 Apply sealant to outside of joint to manufacturer's recommendations.
- .2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations.

3.5 Leakage Tests

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual and SMACNA Class 12.
- .2 Do leakage tests in sections.
- .3 Make trial leakage tests as instructed to demonstrate workmanship.
- .4 Do not install additional ductwork until trial test has been passed.
- .5 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.
- .6 Complete test before performance insulation or concealment Work.

END OF SECTION

Ductwork Accessories

PART 1 - GENERAL**1.1 General**

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to General Mechanical Requirements Section 23 05 00 as applicable.

1.2 Related Sections

- .1 Noise and Vibration Control: Section 23 05 48.
- .2 Thermal Insulation for Ducting: Section 23 07 13.

1.3 Submittals

- .1 Shop Drawings: Prepare and submit shop drawings for all equipment and systems covered by this section.
- .2 Operational and Maintenance Data: Provide equipment literature, operating instructions, maintenance instructions, parts lists, and other pertinent data for all equipment and systems covered by this Section.
- .3 See Sections 01 33 00 and 01 78 00.

PART 2 - PRODUCTS**2.1 Flexible Duct Connections**

- .1 Acceptable Manufacturers

Duro-Dyne	"Grip-Loc Type SMFN"
Ventfabrics	"Ventglas"
Hardcast	
- .2 Furnish flexible duct connections between fans and/or air handling units and connecting ductwork, between unit components, in ducts at building expansion joints, and in other locations shown on Drawings.
- .3 Furnish flexible connectors of heavy glass fabric double coated with neoprene and attached to 0.6 mm (24 ga) metal strips 75 mm (3") wide. Furnish flexible connectors with length of fabric between metal strips of minimum 75 mm (3") for ducts of maximum size in either dimension or diameter of 750 mm (30") or less, and 150 mm (6") for ducts of 775 mm (31") size and larger.

Ductwork Accessories

2.2 Balancing Dampers

- .1 Furnish balancing dampers, manually operated opposed blade type, splitter type, or butterfly blade type, fabricated from galvanized steel sheet of thicknesses specified herein and complete with standoffs and extensions to permit for installation of insulation on the damper.
- .2 Furnish factory built opposed blade type balancing dampers, with galvanized channel type frames, non-binding pre-lubricated type linkage, and blades fabricated of minimum 1.6 mm (16 ga) core thickness material. Furnish damper blades of 200 mm (8") maximum width, and of length coinciding with frame opening on horizontal plane to maximum length of 1200 mm (48").
- .3 Furnish opposed blade balancing dampers complete with inter-connecting linkage, manual operator and locking type quadrant as required for synchronous operation and setting of blades.
- .4 Except where shown otherwise on Drawings, furnish splitter dampers in supply and return ductwork where main ducts are split into two more trunks, and at branch duct connections to main or trunk ducts. Fabricate splitter dampers from same material and thickness as ducts in which they are to be installed, down to minimum of 0.8 mm (22 ga). Furnish splitters formed of double thickness of metal and with rounded surface at air entering edges. Furnish length of splitter at least 1-1/2 times width of smaller branch duct, but in no case less than 300 mm (12"). Provide splitter dampers with locking type quadrant.
- .5 Furnish butterfly blade balancing dampers for round ducts (other than fume exhaust system) fabricated of 1.6 mm (16 ga) metal and with locking type quadrant.

2.3 Volume Extractors

- .1 Acceptable Manufacturers: Titus, Nailor Hart, Kruger, Approved Alternate
- .2 Furnish extractors with #3 manual operator and mounting bracket, where noted on Drawings.

2.4 Fire Dampers

- .1 Acceptable Manufacturers: Controlled Air, Ruskin, Advanced Air, Nailor Hart, Approved Alternate
- .2 Furnish fire dampers of hinged, fusible link type with channel frames, blades and housing, ULC labeled and conforming to NFPA 90A requirements. Furnish "Type B" fire dampers for rectangular or square ductwork and "Type C" fire dampers for round ductwork.
- .3 Furnish fire dampers and frame constructed of same material as duct in which they are installed.

Ductwork Accessories

2.5 Access Doors in Ductwork

- .1 Furnish access doors in ductwork and for plenums to allow servicing, maintenance, and inspection of control dampers, fire detectors, both sides of fire dampers, control elements, bearings and as shown on Drawings. Furnish access doors at least 300 mm x 150 mm (12" x 6") unless duct dimensions prevent, or as required. Where motors are installed within unit or duct, furnish access door large enough to permit removal of same.
- .2 For installation in insulated ductwork and plenums, furnish access doors of 0.8 mm (22 ga) thick galvanized steel sheet double panel construction with approved 25 mm (1") thick insulating filler, in flanged collar flush with face of finished insulation.
- .3 Furnish access doors for installation in uninsulated ductwork and plenums from 18 gauge (1.2 mm) galvanized steel sheet, with door frames welded in place.
- .4 Furnish access doors in air conditioning and ventilation systems with heavy continuous hinges, three heavy sash fasteners and sponge neoprene gaskets to ensure air-tight fit at operating pressure.

2.6 Probe Inlets

- .1 Furnish probe inlets with Ventlok No. 699 or Duro-Dyne IP-1 or IP-2 or Ductmate Test Opening Enclosures complete with locking cap, chain, gaskets, insulating plug, and extensions for insulated ductwork.
- .2 Furnish probe inlets in main supply and return ducts, inlet and outlet side of fans, and other locations as required by Testing and Balancing Trade, to permit testing, balancing and measurement of air quantities and static pressure in air handling systems.

PART 3 - EXECUTION

3.1 Installation

- .1 Install miscellaneous steel framing, supports, braces, etc. as may be required to hang or support equipment and ductwork as specified herein, and as shown on Drawings.
- .2 Flexible Duct Connections
 - .1 Install flexible connectors with fabric in folds, not drawn tight.
 - .2 Install guides to prevent flexible connection from collapsing on suction side of fans.
 - .3 For installation between sections of air handling units, install flexible connectors suitable for connecting to flanges of casings where so provided.
- .3 Balancing Dampers
 - .1 Install dampers at locations in supply and return ductwork where main ducts are split into two more trunks, and at branch duct connections to main or trunk ducts.

Ductwork Accessories

.4 Fire Dampers

.1 Install fire dampers in accordance with suppliers instructions, complete with retaining angles on both sides of wall or floor and fastened to damper collars.

.2 Install fire dampers complete with adjacent access door as required to permit re-opening of damper and replacement of fusible link.

.5 Relief Dampers: Install steel angle or channel frames at wall openings as required to mount relief damper (complete with fire damper) as shown on Drawings.

.6 Access Doors in Ductwork

.1 Install access doors in ductwork and in plenums to allow servicing, maintenance, and inspection of control dampers, fire dampers, fire detectors, control elements, bearings and as shown on Drawings.

.7 Probe Inlets

.1 Install probe inlets in ductwork at locations as specified under Part 2 - Products.

.2 Locate probe inlets sufficient distance from elbows or transition sections to ensure stable readings of non-turbulent air and install 75 mm (3") from corners and at 150 mm (6") centres across long side of duct.

END OF SECTION

Flexible Ducts

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Summary

- .1 Section Includes:
 - .1 Metallic insulated.
 - .2 Materials and installation of flexible ductwork, joints, and accessories.

1.3 Related Sections

- .1 Section 23 33 00 – Ductwork Accessories.
- .2 Section 23 36 00 – Air Terminal Units

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Co-ordinate submittal requirements and provide submittals required by Section 01 47 15 - Sustainable Requirements: Construction.
- .3 Product Data: submit WHMIS MSDS in accordance with Section 02 61 33 - Hazardous Materials for the following:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.
- .4 Samples: submit samples with product data of different types of flexible duct being used in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

2.1 Metallic - Insulated

- .1 Spiral wound flexible aluminum with factory applied, 37 mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl jacket, as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.

Flexible Ducts

- .2 Maximum relative pressure drop coefficient: 3.

PART 3 - EXECUTION

3.1 Duct Installation

- .1 Install in accordance with: SMACNA.
- .2 Maximum length of flexible duct shall be 4 m.

END OF SECTION

Duct Liners

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Related Sections

- .1 Section 23 31 14 – Ductwork – Low Pressure Metallic.

1.3 Submittals

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

2.1 Duct Liner

- .1 General
 - .1 Mineral Fibre duct liner: air surface coated.
 - .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102, NFPA 90A and NFPA 90B.
 - .3 Fungi resistance: to ASTM C1338.
- .2 Flexible:
 - .1 Use on round or oval surfaces surfaces indicated.
 - .2 25 mm thick, to ASTM C1071 Type 1, fibrous glass blanket duct liner.
 - .3 Density: 24 kg/m³ minimum.
 - .4 Thermal resistance to be minimum 0.74 (m².degrees C) /W for 25 mm thickness with ASTM C177, at 24 degrees C mean temperature.
 - .5 Maximum velocity on coated airside: 25.4 m/sec.
 - .6 Minimum NRC of 0.65 at 25 mm thickness based on Type A mounting to ASTM C423.

2.2 Adhesive

- .1 Adhesive: to NFPA 90A and NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 degreesC to plus 93 degreesC.
- .3 Water-based fire retardant type.

Duct Liners

2.3 Fasteners

- .1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Polymer retaining clips, 32 mm square.

2.4 Joint Tape

- .1 Poly-Vinyl treated open weave fiberglass membrane 50 mm wide.

2.5 Sealer

- .1 Meet requirements of NFPA 90A and NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 degrees C to plus 93 degrees C.

PART 3 - EXECUTION

3.1 General

- .1 Do work in accordance with SMACNA HVAC DCS and as indicated except as specified otherwise.
- .2 Line inside of ducts where indicated.
- .3 Duct dimensions, as indicated, are clear inside duct lining.
- .4 Provide duct liner for all heat pumps units supply and return ducts and 6m of energy recovery unit supply and exhaust duct and 6 m of energy recovery ventilators supply and exhaust ducts. Soundline 1800 mm of exhaust fans ducts starting at the fan.

3.2 Duct Liner

- .1 Install in accordance with manufacturer's recommendations, and as follows:
 - .1 Fasten to interior sheet metal surface with 90 % coverage of adhesive to ASTM C916.
 - .1 Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.
 - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres impact driven mechanical fasteners to compress duct liner sufficiently to hold it firmly in place.
 - .1 Spacing of mechanical fasteners in accordance with SMAC HVAC DCS. In systems, where air velocities exceeds 20.3 m/sec, install galvanized sheet metal noising to leading edges of duct liner.

Duct Liners

3.3 Joints

- .1 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:
 - .1 Bed tape in sealer.
 - .2 Apply two coats of sealer over tape.
- .2 Replace damaged areas of liner.
- .3 Protect leading and trailing edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

END OF SECTION

HVAC Fans

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to General Mechanical Requirements: Section 21 05 00 as applicable.

1.2 Related Sections

- .1 **Section 25 90 00: Building Management System.**
- .2 Section 23 05 48: Noise & Vibration Control
- .3 **Section 25 90 01: Sequence of Operation**

1.3 Submittals

- .1 Shop Drawings
 - .1 Submit shop drawings in accordance with Division 1.
 - .2 Submit manufacturer's certified shop drawings to the Consultant and include:
 - .1 Complete information on fan construction and performance.
 - .2 Performance curves over full range from shut-off to free delivery.
 - .3 Drive details.
 - .4 Make, type and catalogue number of bearings.
 - .5 State hour rating of bearings when specified.
- .2 Operation and Maintenance Data
 - .1 Submit printed operating instructions and maintenance data in accordance with Section 01 00 10, as follows:
- .3 Maintenance Materials
 - .1 Provide and turn-over to Owner at time of Substantial Completion one V-belt set for each size used.
 - .2 Where more than one fan uses the same set size, provide only one set.

PART 2 - PRODUCTS

2.1 General Requirements

- .1 Performance Ratings
 - .1 Type, size and capacity shown on Drawings for each specific application and conforming to requirements of manufacture, operation and performance as specified.

HVAC Fans

- .2 Select fan size, operating rpm and rating point on stable head flow curve with smooth characteristics.
- .3 Operating at least 20% below first critical speed when operating at maximum speed for class of construction.
- .4 Dynamically and statically balance wheels of free standing or unitary fans to acceptable tolerances relative to size and speed.
- .2 Cleaning and Metal Protection
 - .1 Thoroughly clean interior and exterior surfaces of fans including screens, at factory with approved de-greasing agent to CGBS 1-GP-181M+ Amdt-Mar-78.
 - .2 Apply a coating of red oxide or zinc chromate primer unless special protective coating is specified.
 - .1 Exception: fans constructed of galvanized steel or aluminium
- .3 Materials
 - .1 Fan casings: heavy gauge steel or spun aluminium construction, as specified by model number.
- .4 Bearings
 - .1 Service life
 - .1 To L10 Life Standard in accordance with latest AFBMA Code.
 - .2 Type
 - .1 Grease lubricated ball or roller type fan bearings with ample thrust provision to prevent end play during normal life of bearings.
 - .2 Smaller than 36 mm diameter: cartridge type.
 - .3 36 mm diameter and larger: shaft adapter sleeve type bearings utilizing horizontally split pillow blocks and mechanical flinger type grease valves.
 - .4 Shafts smaller than 56 mm diameter, interference fit bearings may be used in lieu of adapter sleeve type.
 - .3 Bearings in air stream
 - .1 Well secured extended grease lubricating lines unless bearing is easily accessible through man-size access door.
 - .2 Pack bearings with low temperature grease in factory.
 - .4 Grease fittings, for fans driven by motors 0.375 kW (1/2 HP) and larger
 - .1 Provide bearings with Zerk or Alemite grease fittings, with provision for automatic relief of lubricant pressure to outside of fan, away from wheel and visible from maintenance location.
 - .2 Use service fittings and relief fittings easily accessible from maintenance locations and at separate and opposite sides of bearing housing.

HVAC Fans

.5 Motors and Drives

.1 Motor ratings

.1 To Section 23 05 13.

.2 Type, kW (HP) rating, motor speed and electrical characteristics shown on Drawings.

.3 Capable of satisfactory operation over range of performance from shut-off to run-out at 110% of rated rpm at point of selection.

.2 Drive and belt guards: to Section 23 05 01.

.6 Accessories

.1 Casing drains

.1 Fans discharging vertically through roof: fitted with 38 mm casing drains.

.2 Roof mounted fans

.1 Factory mounted unfused disconnect switches wired to motor terminals.

.2 Conduit or wiring post running through fan housing so that wiring may be run to line side of disconnect switch from below roof without disturbing roof construction.

.3 Roof curbs for roof mounted fans and ventilators

.1 Prefabricated insulated galvanized steel sheet curbs for mounting to roof deck.

.2 Minimum curb height: 450 mm on every side, or as dimensioned on drawings.

2.2 Fan Types

- .1 Each roof exhauster shall be Penn "Domex" axial roof ventilators mushroom with 'V' belt or direct drive as noted; of aluminum construction with parts exposed to weather of aluminum or stainless steel. Fan wheels shall be backward curved, non-overloading centrifugal design with permanently lubricated ball bearings. Tip speed velocity shall NOT exceed that scheduled. Motor H.P. shall be NOT less than scheduled and mounted out of air stream. Each fan on roof shall have suitable base for mounting on 450 mm prefabricated roof curb and platform provided by this Section, have weather tight fastenings and integral C.S.A. approved HP rated disconnected switch mounted inside cover.

Motor and fan assembly shall be on vibration isolation mounts and be quiet operating. Hood shall be 360 degree circular style easily removable to permit access to backdraft damper. Discharge outlet shall have 12 x 12 mm mesh aluminum or vinyl coated steel birdscreen rigidly secured. Each unit shall be in paintable prime coat finish as previously noted. Provide roof curb for each roof exhauster.

HVAC Fans

Provide gravity backdraft damper on each exhaust fan. Backdraft damper shall be of multi-bladed type with aluminum blades, neoprene edged and secured. Bearings shall be corrosion resistant located inside rigidly constructed frame of heavy gauge painted steel. Blades shall be inter-connected with tie rod on inside of frame which shall be weather-stripped all round and have counter-balanced arrangement to hold blades fully open when fan is on and tightly closed when fan is off.

- .2 Hood/exhaust fan assembly shall be Broan exhaust hood fitted with exhaust fan, built-in light with switches and bulbs, filter and #639 wall cap or roof cap as shown each with weather damper. Hood shall be in colour selected by Architect.
- .3 Each concealed ceiling cabinet type exhaust fan shall be Penn "Zephyr" exhaust fan complete with acoustically lined fan housing, gravity backdraft damper, rubber mounted direct driven centrifugal fan with cord, plug and receptacle box, duct collars and wall cap as scheduled.
- .4 Each ceiling circulating fan shall be Plum Circulating Fan.
- .5 Alternate Equipment:

- .1 Jenn Air
- .2 Carnes Corp.
- .3 Loren Cook
- .4 Greenheck
- .5 Approved Alternate

For Exhaust Fan/Hood Unit

- .1 Air King Limited
- .2 Emerson Pryne of Canada Ltd.
- .3 Approved Alternate

Circulating Fans

- .1 Wilcorp
- .2 Banvil
- .3 Pleasantaire
- .4 Approved Alternate

PART 3 - EXECUTION

3.1 General

- .1 Fan Installation
 - .1 Install fans complete with resilient mountings and restraining snubbers in accordance with Section 23 05 48.
 - .2 Provide flexible connections on inlet and outlet ductwork: in accordance with Section 23 33 00.

HVAC Fans

- .3 Align shafts, belt drive and motor, adjust belt tension and check motor rotation before start-up.
- .4 Protect motors and fans during construction and rotate fans, by hand, every month between delivery and acceptance of building.
- .5 Hang cabinet fans with vibration isolators from building structure.
- .2 Air Balancing
 - .1 Adjust variable pitch fan/motor sheaves during balancing to achieve specified air quantities.
 - .2 Provide sheaves and belts for final air balance.

END OF SECTION

Air Curtains

PART 1 - GENERAL

1.1 General

- .1 This section includes air curtains with electric heated.

1.2 Related Sections

- .1 Section 25 90 00 – Building Automation System.
- .2 Section 21 05 01 – Mechanical General Requirements.

1.3 Reference Standards

- .1 UL 507 – Standard for Electric Fans
- .2 UL 1995 – Heating and Cooling Equipment
- .3 UL 2021 – Standard for Fixed and Location-Dedicated Electric Room Heaters
- .4 AHRI 410 – Forced-Circulation Air-cooling and Air-Heating Coils
- .5 CRN – Canadian Registration Number Coil
- .6 NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- .7 NEC – National Electric Code.
- .8 SPE-1000 – Electric Safety Approvals for general electrical products
- .9 NSF 37 – Air Curtains for entranceways in food and foodservice establishments – ETL Sanitation
- .10 AMCA 211 – Certified Rating Program - Product Rating Manual for Fan Air Performance
- .11 AMCA 220 – Laboratory Methods of Testing Air Curtains for Aerodynamic Performance Ratings
- .12 AMCA 222 – Application Manual for Air Curtain Units
- .13 AMCA 311 – Certified Ratings Program – Product Rating Manual for Fan Sound Performance

1.4 Submittals

- .1 Shop Drawings
 - .1 Submit shop drawings in accordance with Division 1.
 - .2 Product Data
 - .1 Manufacturer's datasheet
 - .2 Rated capacities including but not limited to: Airflow (CFM), discharge velocity (FPM), electrical ratings (FLA, amp draw, volt/phase), weight (lbs.), dimensions.

Air Curtains

- .3 Mechanical drawings
- .4 Wiring diagrams
- .5 Standard and optional product features and accessories
- .3 Shop Drawings: For air curtain components not adequately described by product data. Show configuration of non-standard units. Include plans, elevations, sections, details, and attachments to other work. Provide wiring diagrams for power, signal, and control wiring.
- .4 Installation, Operation and Maintenance Instructions: Submit manufacturer's manual, including installation, operation, maintenance, adjustment, cleaning instructions, troubleshooting guide, and electrical wiring diagrams.
- .5 Manufacturer's warranty statement for products and parts.

1.5 Quality Assurance

- .1 Comply with AMCA 211 in terms of the airflow rate, average outlet velocity, velocity projection, and power rating.
- .2 Comply with AMCA 311 for fan sound performance
- .3 ESAFE – Tested in accordance with CSA SPE-1000
- .4 Obtain each type of air curtain through one (1) source from a single manufacturer.

1.6 Delivery, Storage, And Handling

- .1 Deliver air curtains in factory labeled packages.
- .2 Store air curtains in manufacturer's unopened packaging until ready for installation.
- .3 Store and handle air curtains in compliance with manufacturer's instructions.
- .4 Protect from damage due to weather, excessive temperature, and construction operations.

1.7 Warranty

- .1 Standard five-year limited parts warranty from the date of invoice for ambient, electric heated and hot water heated units against defects in workmanship and material.

PART 2 - PRODUCTS

2.1 Manufacturers

- .1 Basis-of-Design Manufacturer: The design for air curtains is based on products supplied by Schwank Ltd.

Air Curtains

2.2 Air Curtain

- .1 Acceptable Products: Schwank Air Curtain Select14 (4000) Series Electric Heated

2.3 Components

- .1 Construction
 - .1 Provide factory-assembled units of sufficient structural strength ready to mount without intermediate support. Ship units completely assembled.
 - .2 Material: Corrosion proof housing made of hot zinc plate and powder coated steel panels. Front and service hatch made of powder coated aluminum.
 - .3 Finish and Color:
 - .1 Service Hatch: White – RAL 9016, Powder Coated
 - .2 Outlet Grille & Body: Grey – RAL 7046, Powder Coated
- .2 Motor/Fan Assembly
 - .1 Forward Curved Centrifugal Fan with plastic housing driven by a rotor motor with EC Technology supplied with integrated thermal protection
 - .2 Motor protection shall be IP 54
- .3 Inlet Grill
 - .1 Inlet grille shall be manufactured from hot zinc-plate and powder coated steel Grey RAL-7046 panels
- .4 Discharge Nozzle
 - .1 Discharge nozzle shall be high efficiency small pockets “Eggcrate” type design. Air curtain creates a positive air seal with directional airfoil vanes.
 - .2 Provide uniform velocity across the width of the air curtain.
- .5 Heating Elements
 - .1 Electric Heating Elements (Electric Heated Elements): Open Element Finned Tubular Type Heating coils factory installed and wired, thermally protected via cut-off switch. Supply should be 3-phase at the voltage required by specified product.

2.4 Controls

- .1 Automatic control with Select14 (4000) Series Controller Package:
 - .1 Wall Mounted Controller/Thermostat. The controller to be set up to control indoor air temp when the door is closed. The equipment to be staged so that it runs at low speed to maintain space temperature and high speed when the door is open.
 - .2 Control Cables
 - .3 Outside Temp Sensor

Air Curtains

- .4 Door contact switch

2.5 Alternate Equipment

- .1 Dynaforce
- .2 Mars
- .3 Powered Aire

PART 3 - EXECUTION

3.1 Examination

- .1 Verify that door frame and adjacent construction completed sufficiently and openings to receive air curtains are level, accurately aligned and correctly located.
- .2 Verify that utilities are at the correct location and are of correct capacities for specified products.
- .3 Examine surfaces to receive air curtains. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Installation

- .1 Install each air curtain in accordance with approved shop drawings and manufacturer's Installation Instructions.
- .2 Install a wall controller and switches were indicated on-site drawings.

3.3 Field Quality Control

- .1 After installing air curtains completely, perform a visual and mechanical check of individual components. Start unit to confirm motor rotation and unit operation.
- .2 Test and operate air curtain to ensure that it performs as intended.

3.4 Cleaning

- .1 Clean air curtain prior to commissioning in accordance with manufacturer's instructions.
- .2 Repair or repaint minor damages to finishes on exposed-to-view surfaces in accordance with the manufacturer's instructions and as approved by Architect.

Air Curtains

3.5 Demonstration

- .1 Instruct the Owner's maintenance personnel how to adjust, operate, and maintain air curtains.

END OF SECTION

Air Terminal Units

PART 1 - GENERAL**1.1 General**

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Related Sections

- .1 Painting: Section 09 91 00, Painting and Finishing.
- .2 Ductwork: Section 23 31 14.

1.3 Submittals

- .1 Shop Drawings: Prepare and submit shop drawings for all equipment and systems covered by this section.
- .2 Record Drawings
 - .1 Record, as work progresses, on one set of white prints provided, all changes or deviations in location of ductwork, dampers, terminal equipment, and equipment and such other approved changes that occur during the progress of the Work.
 - .2 Provide at completion of work, one final set of Drawings with all changes correctly marked in red ink.
- .3 Operational and Maintenance Data: Provide equipment literature, operating instructions, maintenance instructions, parts lists, and other pertinent data for all equipment and systems covered by this Section.

PART 2 - PRODUCTS**2.1 Diffusers, Registers and Grilles**

- .1 General
 - .1 Refer to Drawings for neck size, dimensions, capacity, etc. of grilles, registers and diffusers.
 - .2 Catalogue numbers of first named supplier are listed in schedules on Drawings to show required type and style.
 - .3 Furnish supply diffusers and registers to deliver indicated air quantities shown with throw to reach intended space limits without increasing sound level of room. Furnish blank-off baffles where required. Furnish equalizing deflectors on diffusers and in other locations as shown or required.
 - .4 Coordinate placing of diffusers, registers and grilles in ceilings with electrical and ceiling installation trades and exact location to final approval of Consultant.

Air Terminal Units

.2 Diffusers

- .1 Square ceiling diffusers shall be of steel construction and fit 600 mm O.C. T-bar suspended lay-in ceilings. Inner assembly shall be easily removable and adjustable. Diffuser face shall be 600 mm x 600 mm size unless otherwise noted.
- .2 Linear diffusers shall be two-way 108 mm extruded aluminum continuous louvres with opposed blade damper and border frame finishes shall be baked enamel off-white.
- .3 Type A diffusers shall be #SCD-31, of steel construction and fit 610 mm O.C. T-bar suspended lay-in ceilings. Inner assembly shall be easily removable. Diffuser face shall be 610 x 610 mm size unless otherwise noted. Diffusers shall be of adjustable air pattern type.
- .4 Type B diffusers shall be #SCD-A/31, style of steel construction for surface or flush mounting to ceiling. Inner assembly shall be easily adjustable for heat projection. Diffusers shall be of adjustable air pattern type.
- .5 Type E linear bar grille shall be Model LBT225B extruded aluminum continuous in acid etched and lacquered finish complete with opposed blade volume controller, type 271 grille frame with Type C fastening. Return grille shall be similar but less volume control. Provide dummy sections to give continuous appearance as shown on drawing.

Colour of linear bar grilles shall be selected by the architect.

.3 Grilles, Registers

- .1 Grilles and registers shall be of aluminum construction (except where noted) with baked white enamel finish, except in walls where prime coat finish shall be supplied. Aluminum frames and bars shall be extruded from hard stock, free from pits and spots. Joints shall be 'hairline'. Attachment shall be with stainless steel or C.P. screws with 6 mm thick urethane foam gasket set under flange.
- .2 Return air registers, except where otherwise noted, shall be C-21-S-3, with removable key operated volume damper.
- .3 Exhaust or return air registers, except where otherwise noted, shall be #530D/F/S/A/B12, with removable key operated volume damper.
- .4 Exhaust or return air grilles in lay-in ceilings in sizes 300 x 300 mm and larger shall be #80TB/B12 Steel frame return air grille with aluminum eggcrate face plate, 16 mm wide margin to fit 610 mm O.C. lay-in inverted T-bar ceiling, less volume damper. Where located in ducted system, register shall have volume damper.
- .5 Transfer grilles shall be E.H. Price make TLRD Model with grilles on both sides.
- .6 Supply air registers (except where noted) shall be #520/F/S/A/B12 with removable key operated volume damper and shall have throw and deflection noted or required to suit room.

Air Terminal Units

- .7 Exhaust or return air grilles into ceiling spaces shall be #530D/F/S/A/B12 set on transfer duct in ceiling. Where grille size is 300 x 300 mm or larger in ceiling, provide Series 80 grille. Return air grilles in Gym, Cafeteria & Stage shall be heavy duty and of heavy gauge steel.
- .8 Supply air registers in ceilings shall be 520D/F/S/A/B12.
- .4 Acceptable Equipment
 - .1 E.H. Price
 - .2 Titus
 - .3 AirVector
 - .4 Krueger
 - .5 Nailor Hart
 - .6 Metalaire

2.2 Roof Penthouse

- .1 Provide Penn penthouse type roof hood on ducts passing through roof each complete with birdscreen, backdraft damper, etc., except where otherwise noted. Each hood shall be of aluminum construction, stainless steel fitted, degreased and prime and painted.
- .2 Roof penthouse shall be sized to handle air volume noted at not more than 50 Pa maximum exhaust and 31 Pa intake pressure drop.
- .3 Roof penthouse shall be provided with prefabricated curb.
- .4 Alternate Equipment:
 - .1 Exitaire Co.
 - .2 Jenn Air
 - .3 Irving Fan
 - .4 Approved Alternate

PART 3 - EXECUTION

3.1 Installation

- .1 Refer to and comply with applicable requirements specified in Section 21 05 00.
- .2 Install miscellaneous steel framing, supports, braces, etc. as may be required to hang or support equipment and ductwork as specified herein, and as shown on Drawings.
- .3 Install beam clamps or supplementary steel to secure hanger rods, angles and straps to structural steel framing.
- .4 In suspended ceiling areas, adjust final location of grilles and diffusers to suit reflected ceiling plan.

Air Terminal Units

- .5 Set and secure roof penthouse on roof curb and seal weatherproof.

END OF SECTION

Louvers, Intakes & Vents

PART 1 - GENERAL**1.1 General**

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Related Sections

- .1 Painting: Section 09 91 10, Painting and Finishing.
- .2 Ductwork: Section 23 31 14.

1.3 Submittals

- .1 Shop Drawings: Prepare and submit shop drawings for all equipment and systems covered by this section.
- .2 Record Drawings
 - .1 Record, as work progresses, on one set of white prints provided, all changes or deviations in location of ductwork, dampers, terminal equipment, and equipment and such other approved changes that occur during the progress of the Work.
 - .2 Provide at completion of work, one final set of Drawings with all changes correctly marked in red ink.
- .3 Operational and Maintenance Data: Provide equipment literature, operating instructions, maintenance instructions, parts lists, and other pertinent data for all equipment and systems covered by this Section.

PART 2 - PRODUCTS**2.1 Fixed Louvres - Aluminum**

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy 6063-T5.
- .3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.
- .4 Frame, head, sill and jamb: 100 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.
- .5 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
- .6 Screen: 19 mm intake mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.
- .7 Finish: clear anodized.

Louvers, Intakes & Vents

.8 Acceptable Products:

- .1 E.H. Price
- .2 Construction Specialty
- .3 Penn Ventilator
- .4 Nailor Hart
- .5 Ventex

PART 3 - EXECUTION

3.1 Manufacturer's Instructions

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 Installation

- .1 In accordance with manufacturer's and SMACNA recommendations.
- .2 Reinforce and brace as indicated.
- .3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

END OF SECTION

Variable Frequency Drive

PART 1 - GENERAL**1.1 General**

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to General Mechanical Requirements Section 21 05 00 as applicable.

1.2 Related Sections

- .1 Vibration isolation: Section 23 05 48.
- .2 Building Management System: Section 23 09 33.
- .3 Sequence of Operation: Section 25 90 01
- .4 Electrical Wires and Cables: Section 26 05 21
- .5 Pumps: Section 23 21 23

1.3 Submittals

- .1 Shop Drawings
 - .1 Prepare and submit complete shop drawings in accordance with Section 01 33 00 Administrative Requirements.
 - .2 Indicate equipment including connections, fittings, control assemblies and ancillaries, and identify factory and field assemblies.
- .2 Maintenance Data
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 33 00 Administrative Requirements.

PART 2 - PRODUCTS**2.1 Variable Frequency Drive**

- .1 Provide variable frequency drives for two (2) L.T. pumps. One pump is standby for the other pumps. Verify horsepower of existing equipment prior to order VFD's.
- .2 Furnish complete ABB ACH550 BACnet variable frequency drives as specified herein for supply air unit fan. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD shall be housed in a metal NEMA 1 enclosure.
- .3 The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to negate the need for motor derating.

Variable Frequency Drive

- .4 An advanced sine wave approximation and voltage vector control shall be used to allow operation at rated motor shaft output at nominal speed with no derating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and life.
- .5 The VFD shall include a full-wave diode bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.
- .6 The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Local representative panel shop assembly for option panels is not acceptable. The appropriate UL stickers shall be applied to both the drive and option panel, in the case where these are not contained in one panel. When these drives are to be located in Canada, the CSA or C-UL certifications shall apply.
- .7 The VFD shall have a DC link reactor to minimize power line harmonics. VFDs without a DC link reactor shall provide a 3% impedance line reactor.
- .8 The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.
- .9 The VFD shall be able to provide full torque at any selected speed up to base speed to allow driving direct drive fans without derating.
- .10 An automatic energy optimization selection feature shall be provided standard in the drive. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide a 3% to 10% additional energy savings.
- .11 Input and output power circuit switching can be done without interlocks or damage to the VFD.
- .12 An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or decouple the motor from the load to run the test.
- .13 Protective Features
 - .1 Class 20 I2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications.
 - .2 Protection against input transients, loss of AC line phase, short circuit, ground fault, overvoltage, undervoltage, drive overtemperature and motor overtemperature. The VFD shall display all faults in plain English. Codes are not acceptable.
 - .3 Protect VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output with an input voltage as low as 150 volts for 208/230 volt units, and 285 volts for 460 volt units.
 - .4 The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
 - .5 Drive shall have semi-conductor rated input fuses to protect power components.

Variable Frequency Drive

- .6 Drive shall include a "signal loss detection" circuit to sense the loss of the control signal, and shall be programmable to react as desired in such instance.
 - .7 Drive shall be designed and constructed so that input or outputs can be disconnected with the drive running without the need for interlocks.
 - .8 Drive shall catch a rotating motor operating forward or reverse up to full speed.
 - .9 VFD shall be rated for 100,000 amp interrupting capacity (AIC).
 - .10 Drive shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.
 - .11 Drive shall continue to operate without faulting until input voltage exceeds 300 volts on 208/230 volt drives, and 604 volts on 460 volt drives.
- .14 Interface Features
- .1 Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the drive and determine the speed reference.
 - .2 Provide a 24 V DC output signal to indicate that the drive is in Auto/Remote mode.
 - .3 Digital manual speed control. Potentiometers are not acceptable.
 - .4 Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet away using standard 9-pin cable.
 - .5 All keypads shall be identical and interchangeable.
 - .6 Drive may be operated with keypad removed.
 - .7 All drives shall use the same control keypad.
 - .8 To setup multiple drives, it shall be possible to upload all setup parameters to the drive's keypad, place that keypad on all other drives in turn and download the setup to each drive.
 - .9 Display shall be programmable to display in 9 languages including English, Spanish and French.
 - .10 The display shall have four lines, with 20 characters on three lines and eight large characters on one line.
 - .11 Two lines of the display shall allow free programming so that the exact unit controlled by the drive can be identified.
 - .12 A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the drive when the keypad is removed.
 - .13 A quick setup menu with factory preset typical HVAC parameters shall be provided on the drive eliminating the need for macros.

Variable Frequency Drive

- .14 The drive shall be fitted with an RS 485 serial communications port and be supplied with Windows® compatible software to display all monitoring, fault, alarm and status signals. The software shall allow parameter changes to be made to the drive settings, as well as storage of each controller's operating and setup parameters, and remote operation of the drive.
- .15 Two set-point control interface (PID control) shall be standard in the unit. Drive shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.
- .16 Floating point control interface shall be provided to increase/decrease speed in response to switch closures.
- .17 Sleep mode shall be provided to automatically stop the drive when speed drops below set "sleep" level for a specified time. Drive automatically restarts when speed command exceeds set "wake" level.
- .18 Run permissive circuit shall be provided to accept a "system ready" signal to assure that the drive does not start until dampers or other auxiliary equipment are in the proper state for drive operation.
- .19 An elapsed time meter and kWh meter shall be provided.
- .20 The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, No Load Warning, DC Bus Voltage, Drive Temperature in degrees, and Motor Speed in engineering units per application (in percent speed, GPM, CFM). Drive will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.
- .21 Up to four meter displays can be shown at once on the display. This allows the actual value of the follower signal to be shown simultaneously with the drive's response to that signal for ease in commissioning.
- .22 Drive will sense the loss of load and signal a no load/broken belt warning or fault.
- .23 The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses.
- .24 The VFD shall store in memory the last 20 faults and record all operational data.
- .25 Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
- .26 Two programmable relay outputs, one Form C 240 V AC, one Form A 50 V AC, shall be provided for remote indication of drive status.
- .27 Two programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include 0-10 V dc, 0-20 mA and 4-20 mA.
- .28 Two programmable analog outputs shall be provided for indication of drive status. These outputs shall be programmable for output speed, voltage, frequency, amps and input kW.

Variable Frequency Drive

.29 Under fire mode conditions the VFD shall automatically default to a preset speed.

.15 Adjustments

.1 VFD shall have an adjustable carrier frequency.

.2 Sixteen preset speeds shall be provided.

.3 Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves may be automatically contoured to prevent tripping.

.4 Four current limit settings shall be provided.

.5 If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit, inverter overload and motor overload.

.6 The number of restart attempts shall be selectable from 0 through 20 and the time between attempts shall be adjustable from 0 through 600 seconds.

.7 An automatic "on delay" may be selected from 0 to 120 seconds.

.16 Bypass

.1 Provide a manual bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a four position DRIVE/OFF/LINE/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the drive. In the OFF position, the motor and drive are disconnected. In the LINE position, the motor is operated at full speed from the AC power line and power is disconnected from the drive so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power. This allows the drive to be given an operational test while continuing to run the motor at full speed in bypass. Customer supplied normally closed dry contact shall be interlocked with the drives safety trip circuitry to stop the motor whether in DRIVE or BYPASS mode in case of an external safety fault.

.17 Service Conditions

.1 Ambient temperature, -10 to 40°C (14 to 104°F).

0 to 95% relative humidity, non-condensing.

.2 Elevation to 3,300 feet without derating.

.3 AC line voltage variation, -10 to +10% of nominal with full output.

.4 No side clearance shall be required for cooling of any NEMA 1 units, or of any NEMA 12 units of less than 75 HP at 460 volts. All power and control wiring shall be done from the bottom.

Variable Frequency Drive

.18 Alternate:

- .1 Graham
- .2 Kildonan
- .3 Danfoss
- .4 Approved Alternate

PART 3 - EXECUTION

3.1 General

- .1 Wire between VFD and pumps.

END OF SECTION

Energy Recovery Ventilator

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Related Sections

- .1 Painting – Exterior: Section 09 91 00.
- .2 Noise and Vibration Control: Section 23 05 46.
- .3 Building Automation System: Section 25 90 00.

1.3 Submittals

- .1 **Shop Drawings:** Prepare and submit shop drawings for all equipment and systems covered by this section.
- .2 **Operational and Maintenance Data:** Provide equipment literature, operating instructions, maintenance instructions, parts lists, and other pertinent data for all equipment and systems covered by this Section.
- .3 Performance schedule including airflow, heating and cooling capacities, electrical data, unit weight.
- .4 Energy recovery wheel performance characteristics: sensible for HRV (and latent for ERV as applicable) recovery efficiency, frost point based on design conditions, speed range in RPM
- .5 Fan energy consumption: KW of supply and exhaust fans at design condition and watts per CFM calculation defined as: (design condition supply fan watts + design condition exhaust fan watts) / supply fan airflow
- .6 Full fan curve.
- .7 Sound power data by octave band for all openings and radiated through cabinet.
- .8 Electrical schematics including field wiring connections.
- .9 Component details including construction method and materials.
- .10 Control point schematic and complete written sequence of operation.
- .11 Curb mounting details.

1.4 Quality Assurance

- .1 **Regulatory Requirements:** Conform to the requirements of local by-laws, Ministry of Labour Regulations, and authorities having jurisdiction.
- .2 **Safety Listings:** Entire unit shall be UL 1812 or UL 1995 certified and bear a certification label by ETL, UL or CSA.

Energy Recovery Ventilator

- .3 **Performance:** Unit shall meet ASHRAE 90.1 performance requirements.

1.5 Delivery, Storage and Handling

.1 Storage and Protection

- .1 Store equipment away from construction areas where it may be damaged and protected from harmful weather conditions.
- .2 Keep factory shipping packaging in place until unit is ready to be installed.

.2 Rigging

- .1 Follow manufacturer's instructions for rigging and placement of equipment.

1.6 Coordination

- .1 Coordinate all system connections and building penetrations including electrical, gas and duct connections.
- .2 Coordinate curb placement, structural and roofing.

PART 2 - PRODUCTS

2.1 Materials

- .1 All products used in this project installation shall be new and currently under manufacture and shall be the version currently being sold by the manufacturer for use in new installations. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing. Spare parts shall be available for at least five years after completion of this contract.

2.2 Manufacturer

- .1 Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include, but are not limited to:
Swegon
- .2 Manufacturer should be in business for minimum 10 years manufacturing energy recovery ventilators.

Energy Recovery Ventilator

2.3 ERV Units

- .1 ERV units shall be factory assembled and tested. Units shall include insulated steel cabinet with steel base, sensible recovery or total recovery enthalpy wheel as indicated in the equipment schedule, fan and motor assembly, 2" pre-filter rack, 12" bag filter rack, and integral controls. Unit shall be designed based on a modular concept and allow inclusion of pre and post heating and cooling devices in modular sections that can be bolted to the main ERV components. Base ERV shall be single point power with options for multiple power sources for connection to back-up generator.

2.4 Cabinet

- .1 Cabinet shall be nominal 2 inch double wall panel with Rockwool R8, mineral fiber, acoustic and thermal insulation. Insulation shall have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50. Cabinet exterior shall be 20 gauge prepainted steel that meets or exceeds 650 hour salt spray test based on ASTM B117. Liners and other steel components shall be galvanized steel. All seams shall be sealed to provide air tight casing. Outdoor unit shall include a roof with standing seams and integral gutter.
- .2 Doors shall be nominal 2 inch double wall panel with the same construction as cabinet. Doors shall be fitted with hinges and flush mounted door handles. The doors shall have one lockable handle as standard and the handles shall have a two position opening mechanism for improved safety. Position 1 shall open the door approximately 1" against a positive stop, allowing for pressure equalization. Position 2 shall allow the door to fully open. Otherwise, doors must be provided with factory installed positive stopping mechanism, preventing the door from fully opening against a positive or negative pressure.
- .3 The unit will be designed as single side access, allowing service and maintenance to all be completed from one side and allow for compact installation.
- .4 3rd Party Certified Casing Performance:
Units shall be tested in accordance with EN 1886 or equivalent and meet the following criteria:
 - .1 Casing air leakage = A (Airtightness: L2)
Under 1.6 in. wc air leakage rate shall be no more than 3 cfm/100 ft² and under 2.8 in. wc air leakage rate shall be no more than 10 cfm/ft²
 - .2 Thermal transmittance = T3
The cabinet is a nominal 2 inch double wall panel with 1.5 lb. density Roxul R8 insulation
 - .3 Thermal bridging factor = TB3
The ratio between the lowest temperature difference between any point on the external surface and the mean air-to-air temperature difference. Unit shall meet 0.6 bridging
- .5 Units shall be designed so they can be unbolted and broken down into sections for access to restricted locations. All interconnecting wiring shall have quick-connect Molex plugs at each section.

Energy Recovery Ventilator

- .6 Standard dampers shall have extruded heavy gauge 6063 aluminum frame that includes jamb seals. Blades shall be airfoil shaped extruded aluminum and include rubber blade seals. Linkage shall be installed in the frame outside of the airstream.
 - .1 Corrosion resistant dampers shall be available as required by project application.
- .7 All dampers shall include factory mounted, wired and tested actuators. Dampers shall be modulating or two position as required. Provide spring return dampers for outdoor air connections.

2.5 Filters

- .1 Unit shall include side loaded cartridge filter rack suitable for 12" deep, 10 pocket MERV 13 bag filters for supply and return air. Filters will be held in position by an expanding locking device that provides a gasketed seal on all four sides of the filter. Units without filter locking mechanism shall not be acceptable due to requirement to limit filter air bypass.
 - .1 MERV 14 and MERV 15 bag filters shall be available if required by project details.
- .2 Provide factory mounted pressure sensors to measure filter pressure drop across pre-filter and main bag filter. Pressure drop shall be digitally provided to unit controller for utilization in control and alarm sequencing. Unit controller shall monitor filter pressure level and report when filter changes are required. Pressure drop for all filter banks shall be displayed on the unit handheld, touchscreen controls interface panel and provided via BACnet output to the BMS.

2.6 Fans

- .1 Fans shall be mixed flow plenum type with direct drive motor. Fan and motor assembly shall be mounted on common base with internal isolation and be factory balanced as a complete assembly. If not factory balanced as a complete unit then field balance is required, at the expense of the ERV supplier. Fan shall be connected to fan bulkhead by a canvas type flex connector. The fans will be capable of operating in ambient temperatures of up to 104°F.
- .2 Fan motors shall be permanent magnet, synchronous motor type with integral digital motor controller. Fan bearings shall be serviceable type.
- .3 All fans shall be equipped with integral airflow measuring system connected to the unit controller. Airflow quantity shall be displayed on the unit handheld, touchscreen controls interface panel.
- .4 Provide factory installed fan removal rails in the fan section, and 6 point disconnect, to facilitate simple remove fan-motor assembly for service through standard ERV doors. Wiring must be quick connect fittings. Hard wiring will not be acceptable.

Energy Recovery Ventilator

2.7 Energy Recovery Device

- .1 Units shall include rotary heat exchanger that transfers sensible or both sensible and latent energy. Recovery wheel shall be 10" thick, constructed of corrugated aluminum. ERV wheels less than 10" thick will not be acceptable.
- .2 Recovery wheel shall be coated with Zeolite molecular sieve if designed for enthalpy transfer.
- .3 Wheel supports shall be galvanized steel with a rigid steel hub.
- .4 Wheel section shall be provided with a built in, fixed position, purge section. Rotary heat exchanger shall include face and peripheral brush seals.
- .5 Drive motor shall be variable speed type integrated into unit controller and include torque sensing to provide wheel rotation sensing. Rotary Heat Exchangers without rotational speed control (constant speed wheels) are not acceptable.
- .6 Rotary Heat Exchanger air carry over must not exceed 0.45% tested in accordance with EN308:1997
- .7 Rotary Heat Exchangers constructed of material other than aluminum (plastic, etc) are not acceptable.
- .8 ERV wheel motor speed control must be via a DC stepper motor capable of controlling wheel speed between 0.5 and 20 RPM. The use of VFD's for wheel speed control shall not be allowed due to their limited unloading ability.
- .9 ERV rotor shall be AHRI 1060 certified
- .10 A direct outdoor airflow measurement device shall be included
- .11 Manufacturer to provide 5 year parts only warranty on the ERV wheel.

2.8 Cross Contamination (EATR) Control

- .1 Units shall include and utilize the following means to maintain cross contamination (EATR) at less than 0.5% of the supply airflow through the use of brush seals, rotor purge sector, variable speed rotor control to vary the rotor speed with supply airflow modulation, and return air opening pressure balance plates to ensure the correct pressure balance within the unit to ensure purge airflow from the outside airstream to the exhaust airstream:
 - .1 Units shall include standard pressure balancing plates at return air opening. These plates are to be set at startup, based on the pressure differential between supply and return air, to ensure purge airflow moves from the supply airstream to the exhaust airstream. Pressure gradient across the rotor seal must be between 0 and 0.08" and deliver EATR less than 0.5% as certified by 3rd party verification.
 - .2 Unit controls shall include built-in Air Quality Control algorithms. This feature includes standard algorithms in the unit controller and an optional factory installed modulating damper on the return airstream. The unit controls shall constantly monitor the pressure differential between supply and return air and maintain the pressure differential between 0 and 0.08" over the entire operating airflow range.

Energy Recovery Ventilator

2.9 Controls

- .1 Unit shall include an integrated microprocessor based unit controller. The controls shall be located in the integral controls cabinet. All controls shall operate off a transformer from the main power supply for single point power connection. All internal controls and sensors shall be factory prewired and tested. The microprocessor shall have dual Ethernet ports with an internal firewall to allow remote access via third party without compromising the clients internal Network.
- .2 ERV units must utilize built-in controls and ERV wheel speed control algorithms that use wheel speed modulation to
 - .1 Control supply air temperature
 - .2 Prevent wheel frost development – Wheel frost control shall be done by reading wheel pressure differential. With an increase in pressure drop due to frost accumulation the wheel speed will slow providing wheel defrost. Frost controls based upon exhaust air temperature shall not be allowed due to loss of energy savings
 - .3 Modulate wheel speed as supply airflow modulates to ensure maximum purge efficiency and absolute minimum airflow cross-contamination at less than 0.45% EATR at all airflow conditions.
- .3 Provide airflow monitor to measure outdoor airflow through enthalpy wheel. Monitor shall be integrated into unit controller. Airflow accuracy shall be minimum $\pm 5\%$ of design airflow.
- .4 Provide temperature sensors at all 4 positions on the ERV wheel. Display outside air temperature and return air temperature on the unit handheld, touchscreen controls interface panel and provide all 4 temperature readings via BACnet output to the BMS.
- .5 Include each unit with a touch pad type human interface that allows monitoring and control of all unit functions. Human interface shall communicate with unit controller by hardwire connection. Human interface shall be unit mounted.
- .6 The control system will regulate temperatures, airflows and other functions as required. Unit controller shall be pre-programmed with factory tested software for all possible functions. Controller shall utilize a “plug and play” feature that will automatically load and operate any necessary algorithm based on components and accessories that are connected to the controller such as air flow monitors, damper actuators, fans, rotary energy recovery, water control valves, etc.
- .7 The controller shall provide the following, refer to sequence of operation for specific unit control sequences;
 - Control of fans correcting for both changes in total static pressure and air density in both VAV and constant airflow applications.
 - Real time total unit power consumption (fans, ERV wheel motor and controls) as “watts/CFM” monitored through BMS.
 - Fan performance monitoring.
 - Ventilation airflow monitoring and control.
 - Airflow density correction for winter and summer conditions.

Energy Recovery Ventilator

- Energy recovery optimization including operation of rotary energy recovery device.
 - Supplemental heating and cooling when included.
 - Integration to VRF condensing units when included.
 - Frost protection certified to meet the frost protection requirements of Passive House Institute
 - Recirculation module when included.
 - Monitoring alarms, faults and maintenance points including filter changeout.
 - Time and date schedules.
 - Building pressurization.
 - Humidity control.
 - Data logging and trending.
- .8 Include wireless capability via built-in WiFi connection that will allow the client to access remotely via Smart Phone, laptop, tablet, etc without supplemental software.
- .9 If non-factory controls are proposed as an option, a factory witness test is required to show integration and functionality. Controls vendor and manufacturer shall generate and agree upon a unit test plan to test all unit control functions and verify controls features as called out in these specifications.
- .10 Controller shall be BTL certified for BACnet IP and also include Modbus, Lon, and Metasys communication. Communication shall include monitoring, control, alarms, faults and maintenance information.
- .11 Provide factory installed and tested contactors, overloads, fusing, motor speed controllers for supply, exhaust and rotary energy recovery device. Include all necessary control transformers.
- .12 Provide unit mounted non-fused disconnect switch with single point power connection for main ERV.
- .13 Supply all necessary temperature and pressure sensors complete with plug in wiring harnesses for proper option of unit.

2.10 Sequence of Operations

- .1 DDC Controller:
- .1 Controller with integral LCD readout for changing set points and monitoring unit operation.
 - .2 Provided with required sensors and programming.
 - .3 Factory programmed, mounted, and tested.
 - .4 Integral USB and Ethernet ports for updating programs and retrieving log files.

Energy Recovery Ventilator

.2 BMS Interface:

- .1 [BACnet MS/TP]
- .2 [BACnet IP]
- .3 [Modbus RTU]
- .4 [Modbus TCP]

.3 General Operation

.1 Power Up:

- .1 When the unit main disconnect is closed a delay of 10 seconds (adjustable) occurs for the controller to come online.

.2 ERV Unit Start Command:

- .1 An input signal is required to enable the unit operation. The unit will be commanded on by:
 - .1 [Digital input]
 - .2 [BMS command]
 - .3 [Internal time clock]
 - .4 [Enable via controller display]
 - .5 [Outdoor airflow measurement device]
- .2 All types of input that are enabled must be true before the unit will start.
 - .1 The exhaust fan starts after a 3 second delay (adjustable). The exhaust fan will not start until the damper actuator end switch closes.
 - .2 The supply fan starts after a 6 second delay (adjustable). The supply fan will not start until the damper actuator end switch closes.
 - .3 The supply fan, exhaust fan, [heating] are controlled based on the chosen unit operating modes and air conditions.

.3 ERV Unit Stop Command (Or De-Energized):

- .1 The unit can then be commanded off by:
 - .1 [Digital input]
 - .2 [BMS command]
 - .3 [Internal time clock]
 - .4 [Disable via controller display]
- .2 Supply fan and exhaust fan are de-energized.
- .3 All dampers are unpowered and spring return to their default position after a 10 second delay (adjustable).

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- .4 Supply Fan Operation:
 - .1 [The supply fan will operate at a constant speed.]
 - .2 [The supply fan speed will be controlled for:]
 - .1 [Fixed percentage of max speed (0%-100%)]
 - .2 [Supply air flow (CFM)]
 - .3 [Supply duct static pressure]
 - .4 [Room pressure]
 - .5 [IAQ (TVOC)]
 - .6 [Fixed CO2]
 - .7 [CO2 flow]
 - .8 [Outdoor airflow measurement device]
 - .3 The unit will attempt to start the supply fan when the supply fan delay timer expires. When the supply fan starts the supply fan adjustable current switch should close and remain closed until the fan is turned off.
- .5 Supply Fan Status:
 - .1 Once the supply fan current switch closes [heating] operation is allowed. After a delay of 90 seconds (adjustable) from supply fan start signal, if the supply fan current switch is still open the supply fan alarm should be set to true and [heating] operation shall be prohibited. The supply fan status shall be set to true only when the supply fan output is on and supply fan current switch is closed. The supply fan status shall be false in all other circumstances.
- .6 Airflow Measurement Device:
 - .1 A direct outdoor airflow measurement device capable of measuring the minimum outdoor air intake flow shall be provided. This device must measure the minimum outdoor air intake flow with an accuracy of +/-10% of the design minimum outdoor airflow rate, as defined by the ventilation requirements above. An alarm must indicate when the outdoor airflow value varies by 15% or more from the outdoor airflow setpoint
- .7 Fixed Fan Speed Option:
 - .1 The analog voltage command to the supply fan VFD can be set from the unit controller display [or by the BMS]. The adjustable range of 0% to 100% correspond to the minimum and maximum fan operating speed. This supply fan operation mode can be used to field balance the supply air flow rate.

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- .8 Supply Air Flow Control Option:
 - .1 The controller will adjust the supply fan VFD command to maintain the supply air flow rate at a set point. The supply air flow rate set point is entered and adjusted from the unit controller display [or provided by the BMS]. The minimum and maximum values for supply air flow rate set point are unit dependent. An adjustable PI (proportional & integral) loop will compare the measured supply air flow to the air flow rate set point and adjust the fan speed. If the measured supply air flow rate varies from the desired air flow rate by more than 10% (adjustable) for more than 60 seconds (adjustable) a supply air flow rate alarm will be set to true. This supply fan operation mode can be used to provide a constant supply air flow rate as the unit filters become loaded.
- .9 Supply Duct Static Pressure Control Option:
 - .1 The controller will adjust the supply fan VFD command to maintain the supply duct static pressure at a set point. The supply air duct static pressure set point is entered and adjusted from the unit controller display [or provided by the BMS]. The minimum and maximum values for supply air duct static pressure set point are unit dependent. An adjustable PI (proportional & integral) loop will compare the measured supply air duct static pressure to the static pressure set point and adjust the fan speed. If the measured static pressure varies from the desired static pressure by more than 0.05 inches water gauge (adjustable) for more than 60 seconds (adjustable) a supply air static pressure alarm will be set to true. This supply fan operation mode can be used to provide a constant supply duct pressure for VAV systems.
- .10 Room Static Pressure Control Option:
 - .1 The controller will adjust the supply fan VFD command to maintain the room static pressure at a set point. The room static pressure measurement is typically a differential pressure measurement between the room and an adjacent space or outdoors. The room static pressure set point is entered and adjusted from the unit controller display [or provided by the BMS]. An adjustable PI (proportional & integral) loop will compare the measured room static pressure to the static pressure set point and adjust the supply fan speed. If the measured static pressure varies from the desired static pressure by more than 0.05 inches water gauge (adjustable) for more than 60 seconds (adjustable) a supply air static pressure alarm will be set to true. This supply fan operation mode can be used to provide a constant static pressure in an area to control infiltration or exfiltration from an adjacent area or outdoors.

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.11 IAQ (TVOC) Control Option:

- .1 The controller will adjust the supply fan VFD command to maintain the room or return air VOC level at a set point. The VOC set point is entered and adjusted from the unit controller display [or provided by the BMS]. An adjustable PI (proportional & integral) loop will compare the measured VOC level to the VOC set point and adjust the fan speed. The minimum and maximum fan speed commands are adjustable. If the measured VOC level exceeds 1000 ppm (CO₂ equivalent, adjustable) for more than 60 seconds (adjustable) a VOC alarm will be set to true. This supply fan operation mode can be used to provide demand controlled ventilation of a space. The minimum fan speed will provide the required minimum outdoor air when the VOC level is at or below the VOC set point.

.12 CO₂ Control Option:

- .1 The controller will adjust the supply fan VFD command to maintain the room or return air CO₂ level at a set point. The CO₂ set point is entered and adjusted from the unit controller display [or provided by the BMS]. An adjustable PI (proportional & integral) loop will compare the measured CO₂ level to the CO₂ set point and adjust the fan speed. The minimum and maximum fan speed commands are adjustable. If the measured CO₂ level exceeds 1000 ppm (adjustable) for more than 60 seconds (adjustable) a CO₂ alarm will be set to true. This supply fan operation mode can be used to provide demand controlled ventilation of a space. The minimum fan speed will provide the required minimum outdoor air when the CO₂ level is at or below the CO₂ set point.

.13 CO₂ Flow Control Option:

- .1 The controller will adjust the supply fan VFD command based on the measured room or return air CO₂ level. The supply air flow set point is derived from the user entered minimum and maximum CO₂ levels and minimum and maximum desired air flow rates. When the CO₂ level is at or below the minimum CO₂ level the air flow set point is at the minimum and when the CO₂ level is at or above the maximum CO₂ level the air flow set point is at the maximum. Between the minimum and maximum CO₂ levels the air flow set point is linearly scaled. If the measured CO₂ level exceeds 1000 ppm (adjustable) for more than 60 seconds (adjustable) a CO₂ alarm will be set to true. This supply fan operation mode can be used to provide demand controlled ventilation of a space. The minimum fan speed will provide the required minimum outdoor air when the CO₂ level is at or below the CO₂ set point.

.14 Exhaust Fan Operation:

- .1 [The exhaust fan will operate at a constant speed.]
- .2 [The exhaust fan speed will be controlled for:]
 - .1 [Fixed percentage of max speed (0%-100%)]
 - .2 [Exhaust air flow (CFM)]
 - .3 [Supply fan command tracking]

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- .4 [Supply fan flow rate tracking]
- .5 [Room static pressure]
- .3 The unit will attempt to start the exhaust fan when the exhaust fan delay timer expires. When the exhaust fan starts the exhaust fan adjustable current switch should close and remain closed until the fan is turned off.
- .15 Exhaust Fan Status:
 - .1 After a delay of 90 seconds (adjustable) from exhaust fan start signal, if exhaust fan current switch is still open the exhaust fan alarm should be set to true. The exhaust fan status shall be set to true only when the exhaust fan output is on and exhaust fan current switch is closed. The exhaust fan status shall be false in all other circumstances.
- .16 Fixed Fan Speed Option:
 - .1 The analog voltage command to the exhaust fan VFD can be set from the unit controller display [or provided by the BMS]. The adjustable range of 0% to 100% correspond to the minimum and maximum fan operating speed (0 VDC minimum to 10 VDC maximum, adjustable). This exhaust fan operation mode can be used to field balance the exhaust air flow rate.
- .17 Exhaust Air Flow Control Option:
 - .1 The controller will adjust the exhaust fan VFD command to maintain the exhaust air flow rate at a set point. The exhaust air flow rate set point is entered and adjusted from the unit controller display [or provided by the BMS]. The minimum and maximum values for the exhaust air flow rate set point are unit dependent. An adjustable PI (proportional & integral) loop will compare the measured exhaust air flow to the air flow rate set point and adjust the fan speed. If the measured exhaust air flow rate varies from the desired air flow rate by more than 10% (adjustable) for more than 60 seconds (adjustable) an exhaust air flow rate alarm will be set to true. This exhaust fan operation mode can be used to provide a constant exhaust air flow rate as the unit filters become loaded.
- .18 Supply Fan Command Tracking Control Option:
 - .1 The controller will adjust the exhaust fan VFD command to track the supply fan command. The minimum (50%) and maximum (200%) tracking rates are adjustable. This exhaust fan operation mode can be used to maintain proportional supply and exhaust fan commands as the supply fan modulates.

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- .19 Supply Fan Flow Tracking Control Option:
 - .1 The controller will adjust the exhaust fan VFD command to track the supply fan air flow rate. The offset from the supply air flow rate is adjustable from -25% to +25%. An adjustable PI (proportional & integral) loop will compare the measured exhaust air flow to the air flow rate set point and adjust the fan speed. If the measured exhaust air flow rate varies from the desired air flow rate by more than 10% (adjustable) for more than 60 seconds (adjustable) an exhaust air flow rate alarm will be set to true. This exhaust fan operation mode can be used to maintain proportional supply and exhaust air flows as the supply fan modulates and as the unit filters become loaded.
- .20 Room Static Pressure Control Option:
 - .1 The controller will adjust the exhaust fan VFD command to maintain the room static pressure at a set point. The room static pressure measurement is typically a differential pressure measurement between the room and an adjacent space or outdoors. The room static pressure set point is entered and adjusted from the unit controller display [or provided by the BMS]. The minimum and maximum values for the exhaust fan speeds are adjustable. An adjustable PI (proportional & integral) loop will compare the measured room static pressure to the static pressure set point and adjust the exhaust fan speed. If the measured static pressure varies from the desired static pressure by more than 0.05 inches water gauge (adjustable) for more than 60 seconds (adjustable) an exhaust air static pressure alarm will be set to true. This exhaust fan operation mode can be used to provide a constant static pressure in an area to control infiltration or exfiltration from an adjacent area or outdoors.
- .21 Heating Operation:
 - .1 Heating will be locked out if the outdoor air temperature is above 70 degrees (adjustable). The temperature set point can be configured as constant (adjustable) or can be reset by the outside air temperature. Heating will be controlled using the supply air temperature or return air temperature.
- .22 Constant Temperature Option:
 - .1 The controller will stage the heaters or adjust the 0 to 10 VDC analog output to the heating device to maintain the air temperature at a set point. The air temperature set point is entered and adjusted from the unit controller display [or provided by the BMS]. The minimum and maximum values for the air temperature set point are unit dependent and are adjustable. An adjustable PI (proportional & integral) loop will compare the measured air temperature to the air temperature set point and adjust the analog output. A digital output that indicates a call for heating will also be provided. The analog and digital output can be used to control a hot water valve, electric heater, gas heater, or heat pump.

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.23 Reset Air Temperature Option:

- .1 The controller will adjust the 0 to 10 VDC analog output to the heating device to maintain the air temperature at a set point. The air temperature set point is calculated based on the outdoor air temperature. The air set point is adjusted between the 100 degree F maximum (adjustable) and the 70 degree F minimum (adjustable) as the measured temperature varies from the 20 degree F minimum (adjustable) to the 70 degree F maximum (adjustable). These values are entered and adjusted from the unit controller display [or provided by the BMS]. An adjustable PI (proportional & integral) loop will compare the measured supply air temperature to the supply air temperature set point and adjust the 0 to 10 VDC analog output. A digital output that indicates a call for heating will also be provided. The analog and digital output can be used to control a hot water valve, electric heater, gas heater, or heat pump. Coil freeze protection must be provided by others in the field.

2.11 Acceptable Equipment

- .1 E.H. Price
- .2 Haakon
- .3 Mafna
- .4 Engineered Air
- .5 RenewAire

PART 3 - EXECUTION

3.1 Installation

- .1 Refer to and comply with applicable requirements specified in Section 21 05 00. Install unit as per Manufacturer's recommendations. Install vibration isolating pad between unit and roof curb.
- .2 Install miscellaneous steel framing, supports, braces, etc. as may be required to hang or support equipment and ductwork as specified herein, and as shown on Drawings.
- .3 Prior to start-up of fans, blow out complete systems of ductwork with high velocity air for not less than two hours using where possible the installed air handling equipment to full capacity and by blanking off duct sections to achieve required velocity. Do not install air filters prior to blow-out of ductwork systems. Use auxiliary portable blowers for cleaning where installed fan systems are not adequate to blow out complete system free from dust and dirt.
- .4 After duct systems have been blown out, clean interior of plenums, coils, and register, grille or diffuser outlet collars with industrial type vacuum cleaner. On completion of cleaning process, install filters before placing systems in final operation.
- .5 Arrange for manufacturer to certify installation and supervise start-up and commissioning of unit.

Energy Recovery Ventilator

- .6 Provide traps for all drains with at least 25mm" greater trap seal than the maximum static pressure created by unit and run all drains to roof drains.

3.2 Fans

- .1 After installation of fans, rotate fan shafts at least once every month until acceptance of the Work by Consultant.
- .2 Install separation tape sealant between fan and curb.

3.3 Balancing of Air Handling Systems

- .1 Balance air handling systems in accordance with Section 23 05 93 Testing, Adjusting and Balancing and as specified herein.
- .2 Retain an independent firm of Testing Specialists to balance air handling systems subject to approval of Consultant.
- .3 Balancing Specialists shall provide instruments required to test and balance systems, and co-operate with associated trades involved in adjustment of equipment to obtain design performance. Balancing Specialists shall select location of probe inlet fittings in ductwork to assure proper readings. Balance systems in accordance with design requirement shown on Drawings. Immediately report to Consultant deficiencies in systems or equipment performance which result in design requirements being unobtainable.
- .4 On completion of testing, adjusting and balancing of systems, Balancing Specialists shall submit to Consultant typewritten report (4 copies) of his findings, including complete data of fan performance, static pressures, air quantities, final readings at all outlets, and ampere readings of all motors, taken at motor terminals when equipment is operating under full load conditions.
- .5 Balancing Specialists shall submit with each copy of report, locations at which test readings were taken, air volume, velocity and static pressure in each supply and return duct.

END OF SECTION

Make-up Air Units

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 23 05 00 Common Works for HVAC as applicable.

1.2 Related Sections

- .1 Painting: Division 9.
- .2 Vibration and Seismic Control for HVAC: Section 23 05 48.
- .3 Building Management System: Section 25 90 00.

1.3 Submittals

- .1 **Shop Drawings:** Prepare and submit shop drawings for all equipment and systems covered by this section.
- .2 **Operational and Maintenance Data:** Provide equipment literature, operating instructions, maintenance instructions, parts lists, and other pertinent data for all equipment and systems covered by this Section.
- .3 See Sections 01 33 00 and 01 78 00.

1.4 Quality Assurance

- .1 **Regulatory Requirements:** Conform to the requirements of local by-laws, Ministry of Labour Regulations, and authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 Make-Up Air Units

- .1 Acceptable Manufacturers
 - .1 Engineered Air
 - .2 Haakon
 - .3 Ingenia

Make-up Air Units

.2 General

- .1 Air Handling Units shall be built to the level of quality as herein specified and to the description of the Air Handling Unit Schedule.
- .2 Substitution of any product other than that specified, must assure no deviation below the stated capacities, airflow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded. Applications for "equal" or "alternate" must address these factors.
- .3 Air handling units are to be shipped to the job in one piece. Field assembly of the shipped loose items shall be the responsibility of the installing contractor as described in the manufacturers installation instruction. All equipment shall be factory tested prior to shipment. Manufacturer shall provide a factory test proving indirect gas fired burner capable of 15:1 turndown ratio while maintaining minimum 80% efficiency throughout the range.
- .4 The Air Handling Units shall be the product of a Canadian owned firm, built in Canada, with all components made in Canada, where possible. The air handling units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifteen continuous years of proven production experience.
- .5 Outdoor unit shall consist of filter section, supply air fan section, indirect gas heating section, motorized dampers, control panel, temperature sensors, and all other components required for a complete packaged installation.
- .6 Unit component pressure drops and dimensions shall not exceed those shown. Unit energy consumption shall not be greater than that of the specified equipment. Contractor shall be responsible for any changes resulting from other equipment being used.

.3 Casing

- .1 Unit casing shall be of minimum 18 gauge satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two part acid based etching primer. Finish coat shall be electro statically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.
- .2 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.

Make-up Air Units

- .3 Air handling units shall be weatherproofed and equipped for installation outdoors. This shall include generally for the prevention of infiltration of rain and snow into the unit, louvers or hoods on air intakes and exhaust openings with 1"(25mm) galvanized inlet screens; rain gutters or diverters over all access doors; all joints caulked with a water resistant sealant; roof joints turned up 2" (51mm) with three break interlocking design; outer wall panels extend a minimum of ¼"(6mm) below the floor panel; drain trap(s) connections for field supply and installation of drain traps.
 - .4 Units mounted on roof curbs incorporate welded floor to base construction. Floors are of three break upstanding design with welded corners and free of penetrations. Unit underside joints are caulked. Curb shall be seismic type.
 - .5 Air handling units shall be weatherproofed and equipped for installation outdoors. This shall include generally for the prevention of infiltration of rain and snow into the unit, louvers.
 - .6 Unit casing floors shall be fabricated with 18 gauge galvanized steel. Provide reinforcing channels under floor to minimize deflection and prevent 'oil canning' effect.
 - .7 Provide full perimeter roof mounting curb of heavy gauge sheet metal, minimum of 16"(406mm) high, and complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 1" (25mm) upturn on inner perimeter, to provide a complete seal against the elements. External insulation of the roof-mounting curb shall be provided by the Roofing Subcontractor. Curb shall be seismic type.
- .4 Access Doors
- .1 Access Doors shall be minimum 24"X60" where unit height permits. Removal of screwed wall panels will not be acceptable. Provide hinged access doors with fully lined closed cell gasket and lever lock roller handle. Ventlok 310 handles are also acceptable.
 - .2 Whenever possible, hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. Where space constrictions require the use of outward opening doors to an area of positive pressure, a clear warning label must be affixed.
- .5 Insulation
- .1 All units shall be internally insulated with 1" (25mm) thick 1 1/2 lb./cu.ft. (24 kg./cu.m.) density, neoprene coated fibre glass thermal insulation, secured to metal panels with a fire retardant adhesive and welded steel pins at 16" (400mm) o/c. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

Make-up Air Units

.6 Filters

- .1 Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. The filters shall be lift out, from an access plenum upstream of the filters. Lift out 2" (50 mm) filters shall fit into a horizontal track from which they are lifted up and out. 2" (50 mm) Pleated Panel Disposable Filters: Non-woven cotton fabric media with a metal support grid and heavy duty beverage board enclosing frame.
- .2 Provide a metal frame with metal grid for filter bank to prevent the collapse of each filter. The filter media shall have an average efficiency of 30% on ASHRAE Standard 52-76.
- .3 Provide a differential pressure switch across each filter bank to signal a dirty filter light on the unit panel.

.7 Fan Sections

- .1 The forward curve supply fans shall be AMCA rated, and shall be statically and dynamically balanced. The fan sections shall be constructed in strict conformity with the standards of the AMCA and rated in full conformity with the "Standard Test Code for Centrifugal and Axial Fans", approved jointly by ASHRAE and AMCA. The fans shall be properly mounted on heavy duty steel shafts of a size limiting their first critical speed to at least 25% above maximum operating speed. The shafts shall be mounted on heavy duty self-aligning prelubricated ball bearings.
- .2 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type for single 9" (230mm) to 15" (380mm) diameters forward curve fans. All other fans shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 1" (25mm) static deflection designed to achieve high isolation efficiency.
- .3 Drives shall be adjustable on fans with motors 5 HP (3.73 kw) or smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure
- .4 Fan motors shall be rated for fan duty, open drip proof, and high efficient (equal to CSA 390 M 1985) T-frame.

.8 Dampers

- .1 All dampers shall be heavy duty parallel blade, designed to withstand static pressure specified. The shall have nylon bushings, edge and end seals, and thrust washers.
- .2 Provide factory installed damper operators. Damper operators shall be adequately sized and in sufficient quantity to ensure smooth damper operation.
- .3 For heating-ventilating units, provide heavy duty, automatic modulating dampers on fresh and mixing air openings and single blade back draft damper on exhaust opening. Provide shut-off dampers as required to prevent cold air infiltrating building.

Make-up Air Units

.9 Indirect Power Gas Fired Heating Section

- .1 Heating units shall have an indirect natural gas fired heating section that is ETL approved for both sea level and high altitude areas.
- .2 Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed of titanium stainless steel with multi-plane metal turbulators, and shall be of a floating stress relieved design. Heat exchanger shall be provided with condensate drain connection.
- .3 The burner assembly shall be a blow through positive pressure type with an intermitted pilot ignition system to provide a high seasonal efficiency. Flame surveillance shall be with a solid state programmed flame relay c/w flame rod. The burner and gas train shall be in a cabinet enclosure. Insulation in the burner section shall be covered by a heat reflective galvanized steel liner. Atmospheric burners, or burners requiring power assisted venting are not acceptable.
- .4 Operating natural gas pressure shall be 7" (1750 Pa) w.c. Minimum turndown ratio to be 15:1 while maintaining min 80% efficiency.
- .5 Installation and venting provisions must be in accordance with C.G.A. Standard B149.1 - M86, or latest edition. Type A, C, and/or PS venting is required on indoor units, as per approval by local authorities.
- .6 Gas fired units shall be approved for operation in -40 F locations.

.10 Refrigeration Section

General

Compressors in condensing unit shall be hermetic type, 3600 RPM, set on resilient neoprene mounts and complete with line voltage break internal overload protection, internal pressure relief valve and crankcase heater.

Unit mounted coils shall be manufactured by Engineered Air, constructed of copper tube, aluminium fin, copper headers with sweat connections. Dx cooling coil velocity must not exceed 500 FPM.

Refrigerant evaporator type coils shall be equipped with distributors connected to the coil by copper tubes. Where a hot gas bypass is required, the inlet shall be at the refrigerant distributor. Solenoid valves, expansion valves, and related accessories are to be included with the refrigeration system.

Refrigerant coils with multiple compressors shall be alternate tube circuited in order to distribute the cooling effect over the entire coil face at reduced load conditions. Provision for use of thermal expansion valves must be included for variable air volume and/or make-up air applications.

Condenser coils shall be copper tube type, mechanically expanded into aluminum fins. Coils shall be factory tested with air at 300 psig (2070 Kpa) while immersed in an illuminated water tank.

Make-up Air Units

Condenser fans shall be forward curve double width centrifugal type on 1" spring isolation. Motor shall be rated for fan duty, open drip proof, high efficiency, T-frame, and 575 Volt. 3 Phase. 60 Cycle. Entire condensing section shall be mounted above make-up air unit assemble, piped and tested in the factory.

.11 Packaged Air Conditioning Units

Packaged units shall operate down to 50° F (10° C) as standard. Multiple refrigeration circuits shall be separate from each other. Refrigeration circuits shall be complete with liquid line filter-driers, and service ports fitted with Schraeder fittings. Units with 9, 10 and 12 Ton hermetic compressors and all units with semi-hermetic compressors shall also incorporate load compensated thermal expansion valves with external equalizers and combination sight glass moisture indicators. Semi-hermetic compressor units shall have condensers designed for 15° F (8° C) liquid sub cooling and be equipped with suction line filters and liquid line manual shut off valves. The complete piping system shall be purged and pressure tested with dry nitrogen, then tested again under vacuum. Each system shall be factory run and adjusted prior to shipment.

Controls for hermetic compressor units shall include compressor and condenser fan motor contacts, supply fan contacts and overload protection control circuit transformer, cooling relays, ambient compressor lockout, automatic reset low pressure controls, and high pressure controls on compressors over 5 tons. Head pressure actuated fan cycling control shall be provided on all multiple condenser fan units.

Provide five minute anti-cycle timers.

Provide inter stage time delay timers.

Provide hot gas bypass on the lead compressor to maintain adequate suction pressure in the event of low loads. This feature shall be provided on all Make-Up Air applications with less than four stages of cooling control.

Provide low ambient controls for 50° F, (10° C) operation.

Provide compressor service valves for packaged units incorporating hermetic compressors.

.12 Unit Control Panel

An integral control panel shall be provided complete with hinged access door and locking device. All contents shall be labelled and wired to a numbered terminal strip. Wiring shall be colour-coded and number-tagged at each end to match control diagram supplied. Control panels shall include control transformer, fan motor starters, fuses and overloads, both rated at 125% of FLA, control circuit fuses and all controls required for automatic operation with any of the optional accessories selected.

General

Unit component pressure drops and dimensions shall not exceed those shown. Unit energy consumption shall not be greater than that of the specified equipment. Contractor shall be responsible for any changes resulting from other equipment being used.

Make-up Air Units

.13 Control

Electronic control complete with solid state analyzer and discharge thermistor to maintain set point discharge air temperature and provide rapid response to small changes in discharge air temperature, incorporating: modulating gas valve and proportional combustion air, utilizing the Engineered Air Electronic DJM with room air override re-set thermostat, to automatically re-set the discharge temperature from 70 to 95° F, (21.1 to 35° C), without switching to high fire. Modulating damper control is not acceptable.

Provide remote discharge set point adjustment control in remote panel.

Engineered Air C-TRAC electronic temperature control system with the capability of providing up to 4 stages of cooling control to maintain return air temperature. The minimum run and off time for compressors shall be 4 minutes at full load start-up, and may range up to 8 minutes under part load conditions. The C-TRAC shall incorporate a PI (proportional/integral) control scheme that reduces temperature droop by resetting to the set point after each stage is cycled on. C-TRAC shall include:

Modulating return air, control with 1 averaging sensors with built-in modulating high and low limits.

C-TRAC shall include an integrated economizer cycle that will provide the initial response to a call for cooling. The temperature of the mixed air will vary in response to the demand for cooling. After the outside air dampers are fully open, and further cooling is demanded the outside air dampers revert to their minimum position and stage 1 cooling is energized.

In heating range, the C-TRAC will provide a signal to one of the following second level devices: Model DJM controller for Series DJ industrial heater as specified.

.14 Remote Panel

Provide with air handling unit a remote mounted control panel for the purpose of switching and visual indication of operations. Each panel to include the following items:

- Engraved lamicoïd face plate.
- System ON-OFF switch.
- System ON light.
- Heat ON-OFF switch.
- Heat ON light.
- Cool ON-OFF switch
- Cooling ON light
- Clogged filter light with unit mounted filter air pressure switch.

.15 Alternate Equipment

- .1 Engineered Air
- .2 Mafna
- .3 E.H. Price

Make-up Air Units

2.2 Carbon Monoxide Monitoring System

- .1 Supply and install a complete C.O. monitoring system as shown on the drawings and specified herein. The detector shall be an ENMET Model GAS-ALERT MAX-115
Supplier: Kilmer Environmental Mississauga, Ont. (905) 890-8908.
- .2 Provide one control panel with sensors and alarm device for P1 parking area.
The system to include 11 remote CO sensors.
- .3 Control panel shall be CEMA 1, enamel coated steel, and contain LED indicators for high and low alarm, power "on", sensor and fault. . The system shall contain 5 Amp SPDT adjustable time delay relays (delay on and delay off, 0-20 min.) for both high and low alarm levels.
- .4 Power supply to be 115/1/60 input to control panel.
- .5 Systems shall have an internal push to test feature.
- .6 Systems shall have sensor fault indication on the main control panel.
- .7 Provide 1 remote mounted audio/visual alarm with PTA silence switch in parking at lobby entrance.
- .8 The sensors will be electrochemical type to minimize nuisance alarms from background vapours. The calibrated sensor range will be 0-200 ppm with alarm LED status indication at 25 ppm and 75 ppm CO.
- .9 The sensors will be mounted at 1200mm AFF, or in accordance with codes. A common 16/18 guage shielded conductor wire will connect the sensors to the main panel to provide power and the alarms.
- .10 The electrochemical sensors and sensor circuits will have a 3-year parts warranty. Regular calibrations will be required as per the manual.
- .11 Provide a calibration and test gas kit for periodic recalibration of system. Kit shall include carrying case, regulator with tubing and 17L cylinder of non-reactive test gas.
- .12 A factory trained technician can be hired at additional cost to perform initial field calibration check and system verification. Equipment manufacturer shall be capable of providing a maintenance contract for periodic service and calibration of system if requested.
- .13 System shall be 100% Canadian designed and manufactured and have C.S.A. approval.
- .14 Sequence of Operation

On sensing a CO level above 25 ppm at any of the remote sensors the control relay will close to activate low speed exhaust of exhaust fans. The ventilation contact shall remain energized for a minimum of 5 minutes (field adjustable) to avoid fan short cycling.

If CO level exceeds 75 ppm the control relay will close to activate 2nd stage high speed of exhaust fans. Ventilation contacts shall delay 5 minutes (field adjustable) to allow 1st stage to clear alarm and to avoid short cycling.

Make-up Air Units

If CO remains above 75 ppm for 20 minutes the remote audio/visual alarms shall signal fault.

Provide contacts for alarm interface to FAP/BSP where required. Fire alarm system shall be able to Override the CO system to start/stop fan at high speed.

Provide contacts for alarm interface to BSP. A-Panel mounted manual over-side switch shall by-pass sensors and allow manual operation of ventilation equipment while energized.

PART 3 - EXECUTION

3.1 Installation

- .1 Refer to and comply with applicable requirements specified in Section 21 05 01. Install unit as per Manufacturer's recommendations. Install vibration isolating pad between unit and roof curb.
- .2 Install miscellaneous steel framing, supports, braces, etc. as may be required to hang or support equipment and ductwork as specified herein, and as shown on Drawings.
- .3 Prior to start-up of fans, blow out complete systems of ductwork with high velocity air for not less than two hours using where possible the installed air handling equipment to full capacity and by blanking off duct sections to achieve required velocity. Do not install air filters prior to blow-out of ductwork systems. Use auxiliary portable blowers for cleaning where installed fan systems are not adequate to blow out complete system free from dust and dirt.
- .4 After duct systems have been blown out, clean interior of plenums, coils, and register, grille or diffuser outlet collars with industrial type vacuum cleaner. On completion of cleaning process, install filters before placing systems in final operation.
- .5 Arrange for manufacturer to certify installation and supervise start-up and commissioning of unit.
- .6 Provide traps for all drains with at least 25mm" greater trap seal than the maximum static pressure created by unit and run all drains to roof drains.

3.2 Fans

- .1 After installation of fans, rotate fan shafts at least once every month until acceptance of the Work by Engineer.
- .2 Install separation tape sealant between fan and curb.

3.3 Balancing of Air Handling Systems

- .1 Balance air handling systems in accordance with Section 23 05 93 Testing, Adjusting and Balancing and as specified herein.
- .2 Retain an independent firm of Testing Specialists to balance air handling systems subject to approval of Engineer.

Make-up Air Units

- .3 Balancing Specialists shall provide instruments required to test and balance systems, and co-operate with associated trades involved in adjustment of equipment to obtain design performance. Balancing Specialists shall select location of probe inlet fittings in ductwork to assure proper readings. Balance systems in accordance with design requirement shown on Drawings. Immediately report to Engineer deficiencies in systems or equipment performance which result in design requirements being unobtainable.
- .4 On completion of testing, adjusting and balancing of systems, Balancing Specialists shall submit to Engineer typewritten report (4 copies) of his findings, including complete data of fan performance, static pressures, air quantities, final readings at all outlets, and ampere readings of all motors, taken at motor terminals when equipment is operating under full load conditions.
- .5 Balancing Specialists shall submit with each copy of report, locations at which test readings were taken, air volume, velocity and static pressure in each supply and return duct.

END OF SECTION

Ecology Unit

PART 1 - GENERAL

1.1 Related Sections

- .1 210500 Mechanical General Requirements
- .2 230554 Mechanical Identification
- .3 230548 Noise & vibration
- .4 230593 Testing, adjusting & Balancing
- .5 230813 Start-up Performance
- .6 230813 Project Closeout
- .7 250111 Commissioning
- .8 259001 Sequence Of operation

1.2 Submittals

- .1 Shop Drawings: Prepare and submit shop drawings for all equipment and systems covered by this section.
- .2 Record Drawings
 - .1 Record, as work progresses, on one set of white prints provided, all changes or deviations in location of ductwork, dampers, terminal equipment, and equipment and such other approved changes that occur during the progress of the Work.
 - .2 Provide at completion of work, one final set of Drawings with all changes correctly marked in red ink.
- .3 Operational and Maintenance Data: Provide equipment literature, operating instructions, maintenance instructions, parts lists, and other pertinent data for all equipment and systems covered by this Section.

PART 2 - PRODUCTS

2.1 Ecology Unit

- .1 The ecology unit shall be as manufactured by Halton and shall be ULC approved and ETL listed.
 - .1 The unit shall be complete with Electro-Static Precipitator(ESP) Module, Odor Module, Fan Module, and Control Panel. Unit shall be complete with roof curb.
 - .2 Unit efficiency shall be least 95% at 0.4 microns m3/s.

Ecology Unit

- .3 Electro-Static Precipitator (ESP) and Odor modules shall have a 16 ga. Interior and minimum 20 ga. Exterior shell and include a side access door mounted with hinges and over center lever closure latches. The Electrostatic Precipitator (ESP) section access door shall be furnished with electrical interlock. The housing shall be permanently attached and supported by a 4" C-Channel x 4.5 lbs/ ft steel channel perimeter base. The base shall have integrated holes for mounting and lifting. The base and external housing shall be pre-treated and powder coated with thermoset polyester paint
- .2 ELF Filter Module
 - .1 The unit casing shall be fully painted and be a double wall construction reinforced and braced for maximum rigidity. Inner walls shall be 16-gauge liquid tight welded and construction and outer walls shall be minimum 20-gauge steel. Filter sections to be insulated with 1" (25.4mm) insulation to the requirements of ULC. The entire unit will be mounted on a 4" x 5.4 lb/ft. structural steel support base. The unit shall be complete with two stages of filtration.
 - .2 The first stage filter shall be a 15" deep combination Extended Life Filter, MERV 14 rated and classified to UL 900 standard. The filter clean resistance will not exceed 1.04" w.g. and have an overall holding capacity of 7.9 lbs with a nominal face area of 24 x 24 inches. A combination of a MERV 8, 2" pleated filter and MERV 14 Bag filter shall not be used.
 - .3 The second stage filter shall be constructed from HEPA grade medium, 12-inch deep Mini-Pleat V-Bank MERV 16 performance per ASHRAE 52.2 and classified to UL900 standard. The filter clean resistance shall not exceed 0.6 in.w.g.
 - .4 Filter module will include a grease monitoring system that detects when grease bypassing the final filter in the unit. The unit shall be complete with pressure transducers to monitor the condition of each of the stages of filtration, and a pressure transducer to monitor overall airflow cfm. Hinged access doors shall be provided to allow easy access to the filters. It shall detect if the absolute filter in the unit is partially missing due to filter gaps or if a lower alternative manufacturers efficiency final filter is being used.
 - .5 ULC Listed fire damper actuated by fusible link (212°F UL / 212°F ULC) may be located at the outlet.

Ecology Unit

.3 Odor Control Module Selection

- .1 The unit Odor Control Module shall consist of a housing and a self-contained odor reducing system. Activated Carbon Panels - Furnished in a panel with galvanized steel perimeter frame, covered on both sides with perforated plate and enamel painted. Carbon is composed of virgin coconut shell granular activated carbon with a minimum carbon tetrachloride activity of 60% per ASTM D-3467, is 4 x 8 US mesh size, and impregnated with active ingredients to enhance cooking odor molecule removal. Carbon shall have a bulk density of 30 lbs/ft.³ and sized for a minimum gas residence time of 0.15 seconds (applied at the rate of 95 lbs/2000 cfm of exhaust air). Carbon panels shall be held in place by extruded aluminum tracks, integral to the housing. Tracks shall contain flexible, bulb seal gasketing to eliminate air bypass.

.4 Fan Module

- .1 The exterior fan housing shall be fully painted and be constructed from 16 ga.(minimum) steel with all joints suitably reinforced and braced for rigidity. The fan shall be AMCA rated be a DWDI (double width, double inlet), Class 2, backward inclined, with airfoil type blades and with non-overloading characteristics. The complete fan assembly is statically and dynamically balanced. The shaft is ground and polished steel.
- .2 Bearings shall be pillow block type with lubrication nipples. Drives shall be V belt or grip notch with capacity 25% greater than motor horsepower. The fan and motor shall be mounted on a common base which is spring vibration isolated from the fan
- .3 housing. A fire stat shall be located at the fan inlet to stop the fan on high air temperature.
- .4 Hinged access doors shall be provided to allow easy access to fan and motor. Motor starter shall be complete with electrical overloads and electrical disconnect switch.
- .5 Blower shall be AMCA certified, belt driven utility set or mixed flow tubular type as specified, UL 762 listed and sized to perform the specified air volume and resistance to air flow. The blower shall be mounted on 1" deflection, restrained spring isolators. Blower motor control shall be variable frequency drive.

.5 Control Panel

- .1 The control panel shall be constructed from heavy gauge stainless steel and be suitable for surface mounting, remote mounting or recessed wall mounting with front locking screws. Controls shall be complete with touch screen and display shall indicate system operational status, condition of both filter stages, percent (%) filter loaded for each stage, water wash controls, fan speed, fire condition and odor reducing operation. Controls and interconnecting field wiring to be standard 120 volt AC.

Ecology Unit

.6 Variable Volume Control

- .1 M.A.R.V.E.L. common controls platform shall be a custom programmed demand control system. Controls that provide for the complete and independent modulation of exhaust air volumes utilizing a single unit. All functions of the unit and controls system shall be of one manufacturer and a single control system. Multiple controls platforms field integrated shall not be used. The system shall allow operating each hood section independently utilizing a single exhaust fan as shown on contract drawings by use of ULC Listed.

.7 Alternate Equipment

- .1 Spring Air
.2 Quiet-Aire

PART 3 - EXECUTION

3.1 Ecology Unit

- .1 Mount ecology unit on roof curb.
.2 Install as per manufacturer recommendations.

END OF SECTION

Heat Pumps

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.

1.2 Related Sections

- .1 Section 23 05 29: Hangers & Support for HVAC Piping & Equipment.
- .2 Section 23 05 54: Mechanical Identification
- .3 Section 23 05 93: Testing, Adjusting & Balancing
- .4 **Section 25 90 00: Building Management System**
- .5 **Section 25 90 01: Sequence of Operation**

1.3 Submittals

- .1 Shop Drawings
 - .1 Submit shop drawings in accordance with Division 1.

Shop drawings shall include performance data, physical dimension weight, fan data, power requirements, heating & cooling capacity, accessories & controls.
- .2 Operation and Maintenance Data

PART 2 - PRODUCTS

2.1 Heat Pumps

- .1 Heat Pump Units shall be Florida Heat Pumps reverse cycle package heating/air conditioners of models shown on the drawings suitable for ground source application using Loopanol-2 as a thermal fluid. Types, sizes and performances are shown in Heat Pump Unit Schedule. Each H.P.U. shall be U.L. and C.S.A. listed and performance certified by A.R.I. CSA certification shall not be invalidated by inclusion of options noted in this Specification. Heat pumps shall meet or exceed A.S.H.R.A.E 90.1 requirements.
- .2 Units shall be supplied completely factory built and capable of operation with an entering water temperature range from 20° to 120°F (-6.7° to 49°C) as standard. All equipment listed in this section must be rated and certified in accordance with ARI/ISO, NRTL or CSA. The units shall have ARI/ISO, NRTL or CSA labels. All units shall be factory run tested under normal operating conditions at nominal water flow rates. This testing shall generate a report card to be shipped with each unit stating performance in both heating and cooling modes. Serial numbers will be recorded by factory and furnished to contractor for ease of unit warranty status. Units tested without water flow ARE NOT acceptable.

Heat Pumps

- .3 Each H.P. Unit shall contain sealed refrigerant circuit (HFC 410A refrigerant) consisting of field replaceable hermetic motor-compressor, air-to-refrigerant finned tube heat exchanger (for water to air type and water to refrigerant for water to water type), capillary expansion tube, pilot operated refrigerant reversing valve, solenoid valve, water-to-refrigerant coaxial tube heat exchanger, high pressure and low temperature safety cut-outs, motor and filter section with filters. Integral control section shall include all operating and safety controls.
- .4 Each H.P. unit shall be complete with factory mounted automatic flow regulator and water solenoid valve.
- .5 Ceiling mounted models shall be horizontal configuration with horizontal air discharge and return complete with rubber-in-shear isolators. Units shall be built for filter removal in any of three directions.
- .6 Horizontal Units shall have one of the following air flow arrangements: Right-Discharge/Left-Inlet; Left-Discharge/Right-Inlet; Back-Discharge/Left-Inlet; or Back-Discharge/Right-Inlet as shown on the plans. Units must have the ability to be field convertible from side to back or back to side discharge with no additional parts or unit structure modification. Units will have factory installed hanger brackets and isolation grommets. Units will also have factory installed 1" duct collars.
- .7 All units must have a minimum of three access panels for serviceability of compressor compartment. If other arrangements make servicing difficult, the contractor must provide access panels and clear routes to ease service. Architect must approve any changes in layout.
- .8 The horizontal heat pumps shall be fabricated from heavy gauge galvanized sheet metal. All interior surfaces shall be lined with 13 mm thick, 0.67 kgs. acoustic type glass fiber insulation. All fiberglass shall be coated and have exposed edges tucked under flanges to prevent the introduction of glass fibers into the air stream. All insulation must meet NFPA 90A.
- .9 UltraQuiet package shall consist of high technology sound attenuating materials that are strategically applied to the cabinet, in addition to the standard ClimaQuiet system, to further dampen sound.
- .10 Each unit shall be supplied with two flexible metallic hose assemblies for supply and return piping. Each unit shall be supplied with 900 mm long flexible metallic condensate hose assembly of adequate size to accommodate any condensate generated.
- .11 All units must have an insulated panel separating the fan compartment from the compressor compartment. Units with the compressor in the air stream ARE NOT acceptable. Units shall have a factory installed 1 inch wide filter bracket for filter removal from either side. Units shall have a 1 inch thick pleated filter. The contractor shall purchase one spare set of filters and replace factory shipped filters on completion of start-up. Filters shall be standard sizes. If units utilize non-standard filter sizes then the contractor shall provide 4 spare filters for each unit.

Heat Pumps

- .12 Cabinets shall have separate openings and knockouts for entrance of line voltage and low voltage control wiring. Supply and return water connections shall be copper FPT fittings and shall be securely mounted flush to the cabinet corner post allowing for connection to a flexible hose without the use of a back-up wrench. Water connections that protrude through the cabinet or require the use of a backup wrench SHALL NOT be allowed. All water connections and electrical knockouts must be in the compressor compartment corner post as to not interfere with the serviceability of unit. Contractor shall be responsible for any extra costs involved in the installation of units that do not have this feature. Contractor must ensure that units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor.
- .13 Units rated 5 ton and under shall have a direct-drive centrifugal fan. The fan motor shall be 3-speed, permanently lubricated, PSC type with internal thermal overload protection. Blower shall have inlet rings to allow removal of wheel and motor from one side without removing housing. Units supplied without permanently lubricated motors must provide external oilers for easy service. The fan motor shall be isolated from the fan housing by torsionally flexible isolation grommets. The fan and motor assembly must be capable of overcoming the external static pressures as shown on the schedule. CFM/Static pressure rating of the unit shall be based on a wet coil and a clean filter in place. Ratings based on a dry coil and/or no filter SHALL NOT be acceptable.
- .14 Units shall have a sealed refrigerant circuit including a high efficient scroll, rotary or reciprocating compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, an enhanced aluminum lanced fin and rifled copper tube refrigerant to air heat exchanger, a reversing valve, a coaxial (tube in tube) refrigerant to water heat exchanger, and safety controls including a high pressure switch, a low pressure sensor, and a low water and low air temperature sensor. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a lockout device. The lockout shall be reset at the thermostat or at the contractor supplied disconnect switch. Units which may be reset only at the disconnect switch only SHALL NOT be acceptable.
- .15 The compressor will be mounted on external computer selected isolating springs. The external springs will be secured to rails that are isolated from the cabinet base. Compressor shall have thermal overload protection and be located in an insulated compartment away from air stream to minimize sound transmission. Refrigerant to air heat exchangers shall utilize enhanced lanced aluminum fins and rifled copper tube construction rated to withstand 450 PSIG refrigerant working pressure. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 450 PSIG working refrigerant pressure and 450 PSIG working water pressure. Plate to plate heat exchangers ARE NOT acceptable.

Heat Pumps

- .16 Refrigerant metering shall be accomplished by thermostatic expansion valve only. Units intended for use in factory standard built operating range with entering water temperatures from 20° to 120°F (-6.7° to 49°C). Reversing valves shall be four-way solenoid activated refrigerant valves which shall fail to heating operation should the solenoid fail to function. If the reversing valve solenoid fails to cooling, a low temperature thermostat must be provided to prevent over-cooling an already cold room.
- .17 Automatic reset freeze protection shall be provided within each unit to directly protect water coil from freezing using device that will not cause nuisance shut-down because of cold ambient air temperature. Freezestat shall be set at 4oC to provide safe margin against damaging freeze and be in direct contact with circulating water. Indirect sensor is not acceptable and must be modified to ensure direct sensing of leaving water temperature.
- .18 The drain pan shall be constructed to inhibit corrosion and fully insulated. Drain outlet shall be located on pan as to allow complete and unobstructed drainage of condensate. Vertical units will be supplied with factory installed trap inside of cabinet. The unit as standard will be supplied with solid-state electronic condensate overflow protection. Mechanical float switches WILL NOT be accepted.
- .19 Each unit water-to-refrigerant heat exchanger shall incorporate serpentine water coil which will not trap air and be suitable for 200 kpa water circuit design pressure.
- .20 Where units supplied exceed electrical load requirements indicated, supplier shall ensure that all electrical devices such as disconnects, circuit breakers, and wiring are adequately sized to accommodate these loads. Advise Consultant of such changes for their review as part of Shop Drawing processing.
- .21 Where units supplied exceed water pressure drops indicated, supplier shall ensure that all piping, circulating pumps, and other associated equipment is adequately sized to accommodate these pressure drops, as well as any changes to pump motors and associated electrical hardware. Advise Consultant of such changes for their review as part of Shop Drawing processing.
- .22 Each unit shall have extended 4 year Parts and Labour Warranty on complete hermetic refrigeration circuit, F.O.B. suppliers local service centre. This warranty shall include compressor, refrigerant tubing, reversing valve, air coil, and water-to-refrigerant heat exchanger.
- .23 Coefficients of performance (C.O.P.) and energy efficiency ratios (E.E.R.) shown in Schedule are minimum acceptable.

Heat Pumps

.24 Alternate Equipment:

(Include for all electrical revisions necessary to suit equipment including wire sizes, breakers, etc. to suit power supply).

- .1 Climate Master
- .2 McQuay
- .3 Water Furnace
- .4 Johnson Controls
- .5 Approved Alternate
- .6 Trane

PART 3 - EXECUTION

3.1 Heat Pumps

- .1 Division 26 will provide power wiring to each heat pump unit. Division 25 to provide all controls wiring for heat pump units and tie Bacnet interface cards on units to BMS. Startup and configuration of heat pump units and Bacnet interface
- .2 Supply services of factory trained installation representative for at least two site visits during construction period for supervision of system installation, checking and testing of each individual heat pump unit, and start-up and commissioning of entire system complete with operating controls to Owner or his representatives.
- .3 After connection of heat pumps into low temperature (L.T.) water loop, water flow balance shall be conducted to assure proper flow rate to each heat pump. This procedure must be supervised by heat pump manufacturer's factory trained personnel.
- .4 Install each suspended unit in place with steel rods from building structure using inserts provided in place by this Section. Installation shall comply with manufacturers directions and be approved by Consultant. Supply spring type anti-vibration mount at each support point. Hangers and isolators shall not extend below bottom of unit when ceiling mounted. Mount vertical units on 100 mm concrete housekeeping pads. In addition, mount counter flow units on steel stands.
- .5 Co-operate with Sheet Metal Trade to install ductwork for each unit as shown via flexible connectors.
- .6 Pipe each unit into L.T. loop complete with unions at connection. Install ball valves and hoses to approval. Piping shall conform to manufacturers printed directions. Note requirements for flushing piping system.
- .7 Each unit condensate hose shall be coiled by installer to provide minimum 75 mm trap and be connected to condensate disposal system so that all condensate piping is pitched downward from unit.

Heat Pumps

- .8 Start-up each unit, test and adjust controls and components and put each unit and each entire system in safe efficient operating condition to meet design criteria and manufacturer's directions.
- .9 Training
 - .1 Provide training for the Owner's personnel on the operation and maintenance of the Heat Pumps.

END OF SECTION

Earth Loop System

PART 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 Related Sections

- .1 Section 21 05 00 "General Mechanical Requirements"
- .2 Section 23 05 29 "Pipe Hangers and Supports"
- .3 Section 23 05 23 "Valves"
- .4 Section 23 21 14 "Hydronic Specialties"
- .5 Section 23 05 54 "Mechanical Identification"

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.
 - .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.
 - .3 LEED submittals: Submit applicable supporting documentation in accordance with LEED requirements for the approval of the Consultant.
 - .4 Certification:
 - .1 Submit certified documentation from manufacturer for each worker performing Work of this Section.

Earth Loop System

- .2 Submit installer's and Product manufacturer's certification verifying compliance with the Contract Documents and conformance with ASTM E814 and CAN/ULC S115.

1.4 Quality Assurance

- .1 Perform Work of this Section by manufacturer-approved, skilled, qualified, and experienced workers trained in installation of Work of this Section.
- .2 LEED requirements:
 - .1 The LEED requirements shall apply to all Sections and Work for this Project, whether specifically indicated or not.
 - .2 Compliance with requirements needed to obtain LEED prerequisites and credits will be used as one criterion to evaluate requests for substitutions or alternates.

1.5 Site Conditions

- .1 Conform to manufacturer's requirements and maintain a minimum temperature of 50 C for a minimum period of 24 h before application, during, and until application is fully cured.
- .2 Maintain sealant at a minimum 18E C for best workability.

PART 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.
 - .5 Approved Alternate

2.2 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 Firestop sealant: single component, low modulus, silicone rubber, moisture curing, ULC labelled to CAN/CGSB 19.13-M and CAN/ULC S115.
- .3 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.

Earth Loop System

- .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.
- .4 Damming, back-up, supports, and anchorage: In accordance with manufacturer's fire rated systems and to acceptance of authorities having jurisdiction.
- .5 Primer: As recommended by firestopping sealant manufacturer.

2.3 Buried Earthloop Piping

- .1 Equipment and installation shall be by an approved specialty sub-contractor having at least 3 years experience in this type and size of work and having at least 2 similar projects in service at time of bidding.
- .2 The earthloop system contractor shall bid to the mechanical contractor and NOT to the Heat Pump manufacturer. Work of this sub-contractor shall include all related site work and piping up to the steel pipes connection beside the mechanical room.
- .3 The earthloop contractor must have a contractor's license and technician license issued by the Ministry of the Environment (MOE). The earthloop contractor shall be licensed by the Canadian Earth Association (CEEA). He shall be able to perform the requirements of drilling the holes, installing the loops and grouting to both MOE and CEEA specs. He shall have modern equipment capable of performing these functions in a reasonable period of time. He shall have gas detection equipment on site connected and operating.
- .4 System shall include buried earthloop system where shown consisting of reverse supply and reverse return headers and multiple heat exchanger loops drilled into ground.
- .5 Earthloop contractor must ensure that noise level from his operations does not exceed 55 decibels at the property line.
- .6 Earthloop contractor shall provide all earthloop piping exterior to building and up into the building as shown where steel pipe starts. Exterior work includes all horizontal and vertical piping, excavating, backfilling, drilling etc. for this piping.
- .7 Earthloop piping materials shall be in compliance with CSA Standard #B123.1 regarding piping materials for ground source heat pumps. Earthloop pipe shall be Series (160#WWP) #8406 or #3406 resin polyethylene extruded to Schedule 40 I.P.S.
- .8 Vertical earthloops of diameter shown shall be installed in boreholes drilled to depths as shown on Drawings. Earthloop boreholes shall be drilled where shown unless site conditions (slabs, foundations services) change and dictate otherwise. Provide metal sleeves where required to suit ground conditions.

Earth Loop System

- .9 Each vertical pipe loop shall be ready to install and be inserted into borehole as soon as drill stems are removed so as to minimize time for cave-ins and to maximize opportunity for even heat exchanger lengths.
- .10 Space between any two boreholes shall be no closer than 45 meters (150 feet). All boreholes shall be no closer than 3 m to any building, service, waterline or sewer area. See Drawings for details.
- .11 Remove drilled out material from site unless otherwise directed. Excavate and backfill trenches as noted in 210500-1.10. Provide written report confirming that all vertical piping has been backfilled as specified and that all buried horizontal earth loop piping has been backfilled with sand and rigid insulation installed as specified and shown on Drawings.
- .12 All heat pump holes must be completely sealed with impermeable materials to prevent downward migration of contaminants and intermixing of aquifer complexes. Drilling contractors shall provide a bentonite clay/cement mixture to the full depth of each hole. The grouting shall be tremmied or pressure grouted from the bottom of each hole and upward. This must be repeated as required until grouting is cured and settlement is completed.
- .13 For anticipated drilling conditions see test bore hole information which is part of the architectural specifications. Closed Loop Ground Source Sub-Contractors should check local conditions before submitting drilling price. See also soil test report prepared by Geotechnical Consultants and included as part of the architectural specification.
- .14 Vertical earth loop heat exchangers shall be connected together in reverse return fashion where shown 1.5 meters below final grade level. Any breaking of rocks to achieve 1.5 meters deep trenches is the responsibility of the Ground Source Sub-contractor.
- .15 Building entry shall be through 75 mm steel pipe sleeves. Seal gap between PVC pipes and sleeves with Link Seal modular seal.
- .16 Closed loop ground source Sub-Contractor shall have current C.E.E.A. Certified Technician in both butt fusing and socket fusing procedures and techniques. Document must be on site at all times while working is in progress.
- .17 All outside connections shall be fused in field at 254°C to 265°C (490°F to 510°F). No non-fused joints in field will be permitted. U-bends for vertical boreholes shall be butt fused.
- .18 Use minimum of plastic elbows and fittings etc. and maximize flexibility of earth loop pipe material so as to minimize pressure drop throughout system.
- .19 Excavation and backfilling for earthloop system shall be by this section. Refer to Soils Report and Drilling Report. Make due allowance for these conditions in tender price. Include all necessary costs in tender price to accommodate and include all conditions shown in both reports. Both reports are included in the Architectural specifications.

Earth Loop System

2.4 Earthloop Thermal Fluid

- .1 Heat pump system shall have antifreeze solution as heating/cooling medium consisting of special de-natured ethanol 96% solution with strength capable of withstanding freezing to -20°C (-4°F). Solution shall have a stable rust inhibitor and an algicide. The solution is marketed under the name Loopanal-2 by Quatic Industries in Guelph, Ontario (Tel.: 1-800-265-8392).
- .2 The solution shall be premixed off site and trucked to site for pumping into the ground loop system using purging unit. Completely fill entire system venting off all air except in expansion tank leaving 275 kPa residual pressure in system.
- .3 Provide Loopanal-2 solution make-up for ground source loop as shown. Provide 25 mm pipe from pump located in 205 litre drum to top of 250 dia. supply header with shutoff valve and low flow sensor as shown. Install control pressure switch in return header and wire to heat pump central control panel.
- .4 All components on Loopanal-2 system shall be suitable for solution used. Pump seals, gaskets, expansion tanks, valves and other materials must not be affected and have normal life span. Where solution will affect normal life span, provide alternate materials to meet this requirement.

PART 3 - EXECUTION

3.1 Earth Loop Thermal Fluid

- 1 System MUST be cleaned BEFORE filling, by circulating a 1/4% solution by weight of tripotassium phosphate or trisodium phosphate for at least 4 hours at 50°C (40°F) and then drained and flushed with clean water meeting above criteria. Consult with quatic regarding method of cleaning.
- .2 Install two (2) 19 mm valved capped hose end connection in this system for charging system across system pumps and clearly identify both connections as to use.
- .3 Circulate solution in system for at least 48 hours and verify solution characteristics before starting system. Report actual characteristics and lowest safe operating temperature and guarantee same in writing to Architect.
- .4 On completion of work, supply at least one (1) 45 Imperial Gallon (205 litre) drums of premixed solution for topping up system complete with instructions. Drums shall be suitably labeled to show contents. Supply similar empty drum, also labeled for containing solution taken from system complete with bung plugs, etc.
- .5 System shall be purged of all air during and after filling with solution. After one (1) week of operation, repurge system and verify system is 100% full, no air is present and system pressure remains constant at approximately 30 psig (208 kPa) at pumps under no flow condition.

Earth Loop System

3.2 Buried Earthloop Piping

- 1 Clean and flush each earthloop after pressure testing to hold 700 kPa (100 psig) for 24 hours without decrease in pressure. Each pipe loop shall be pressure tested before being layed into trench. Repeat cleaning, flushing and pressure testing after pipe circuit is connected to pipe headers. All earth loop piping circuits shall be left clean and filled with clean water before charging with solution.
- .2 Flush and purge system of debris and air as outlined in CEEA Engineering Manual, Chapter 7. Also see CAN/CSA #C445-M89 and comply thereto. Fill system including interior piping, circulate and reflush and repurge to ensure complete system is clean and free of air.
- .3 Provide written report confirming that all system piping has been cleaned, flushed and pressure tested as per plans and specifications. Co-ordinate with interior piping installer.
- .4 Excavating Subcontractor shall dispose of waters used in excavating or recovered from trenches in safe manner to local and MOE requirements. Such water shall NOT be permitted to flow onto adjacent or municipal properties.
- .5 Supply summary of final pressure readings for all loops and systems at completion of work, AND 12 months into guaranty period.
- .6 Provide glass framed chart showing borehole field with each hole numbered, each supply and return pipe circuit numbered and tagged. Indicate the number of each bore hole connected to each circuit.
- .7 Provide minimum two trace circuits wires to assist in future identification of horizontal pipes in the field. Wires shall be 14 gauge solid copper insulated with TW or equivalent material. Each circuit must be wired from Pump Room out to field in trenches and back in Pump Room. Divide field into two equal areas. Wires shall be CSA approved. Each circuit shall be clearly labelled identified and marked on as built drawings.
- .8 Refer also to report on soil conditions by Geotechnical Consultant. Include all necessary costs in tender price to accommodate and include all conditions shown in reports.

3.3 Test Hole

- .1 Test Well
 - .1 Drill the first well as a pilot test
 - .2 During drilling, record the different soils encountered to provide a summary of the stratigraphy along with its respective accurate depths for an independent Hydro geologist to review later.
 - .3 Follow materials and procedures, CSA 448.1-02 and CSA 448.2-02 Standards and procedures shall apply.

Earth Loop System

- .4 After the well has been drilled, insert a (2 tubes 1.25" diameter each with 'U' bend) geothermal closed loop down to 125 meter level.
 - .5 Immediately after insertion, tremie grout (pressure grout from the bottom up) with either a 20% solid bentonite blend or a 5% bentonite with 95% cement.
 - .6 Pressure test the well to a 100 PSI level to hold for 12 hours.
 - .7 Flow test the well to assure that there is no restriction that occurred during installation.
- .2 Thermal Response Test
- .1 Supply and install a Thermal Response Test Machine.
 - .2 Assure you have continuous power for a minimum of 48 hours.
 - .3 Record the conductivity of the borehole.
 - .4 Record the diffusivity of the borehole.
 - .5 Produce a complete and graphed report for the above tests and drilling.

END OF SECTION

Commissioning

PART 1 – GENERAL

1.1 General Requirement

- .1 Conform to the general conditions in Division 1.
- .2 Conform to the mechanical general conditions Section 21 05 00.
- .3 Conform to the LEED Section.
- .4 Provide labour and mechanical to conduct the commissioning process as outlined in this specification section.

PART 2 - PRODUCTS

2.1 Commissioning

- .1 The General Contractor will ensure the Mechanical Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests specified. The Mechanical Contractor shall advise the Mechanical Consultant of instrumentation to be used and the dates the instruments were calibrated.

PART 3 - EXECUTION

3.1 Commissioning

- .1 The Commissioning Process
 - .1 Within four weeks of contract award, the General Contractor will ensure the mechanical Contractor shall provide complete commissioning schedule. Commissioning schedule shall identify static tests, installations, start-ups, pre-functional and functional tests, air and water balancing, clean building milestone, permanent power milestone, O & M manual, training, seasonal verification, deferred tests, and end of warranty review.
 - .2 The commissioning process consists of:
 - Shop Drawings and Record Drawings
 - Installation inspection and equipment verification
 - Plumbing and drainage system testing
 - Testing of piping systems
 - Independent contractor balancing of water systems
 - Testing of air systems
 - Independent contractor balancing of air systems
 - Testing of equipment and systems
 - BAS Commissioning
 - Performance testing

Commissioning

- Commissioning meetings
- Operating and maintenance manuals
- Training
- Systems Demonstration and turnover
- Testing forms
- Warranties

3.2 Shop Drawings and Record Drawings

- .1 Conform to Section 21 05 00 for requirements for shop drawings and record drawings.

3.3 Installation Inspection and Equipment Verification

- .1 The General Contractor through the Mechanical Contractor shall co-ordinate with the Consultant who will inspect the mechanical installation.
- .2 The General Contractor through the Mechanical Contractor shall complete the equipment verification forms for each piece of equipment. The forms shall be included in the operating and maintenance manual. The equipment data shall include:
 - Manufacturers name, address and telephone number
 - Distributors name, address and telephone number
 - Make, model number and serial number
 - Pumps - RPM, impeller sizes, rated flow
 - Fans - belt type and size, shive type and size
 - Electrical - volts, amps, fuse size, overload size
 - Any other special characteristics.

3.4 Plumbing and Drainage System Testing

- .1 The plumbing and drainage system shall be tested in accordance with the Plumbing Code under the Ontario Water Resources Act and specification section 21 05 00.
- .2 The Mechanical Contractor shall notify the Building Inspector when systems are available for testing. The Mechanical Contractor shall document all tests performed and shall arrange for the Building Inspector to sign for tests completed. The forms shall be forwarded to the Consultant.

3.5 The Contractor's Testing of Piping Systems

- .1 Test all piping systems in accordance with all applicable plumbing codes and specification section 23 21 16.
- .2 All tests for the systems shall be performed in the presence of the Consultant or Commissioning Consultant. Complete the testing forms and forward to the Consultant.

Commissioning

3.6 The Independent Contractors Testing and Balancing Of Water Systems

- .1 Conform with the specification section 23 05 93, Testing, Adjusting and Balancing.
- .2 The Independent Contractor shall be hired by The Mechanical Contractor and shall report to the Commissioning Consultant.

3.7 The Contractors Testing of Air Systems

- .1 Conform with the specification section 23 05 93, Testing, Adjusting and Balancing.
- .2 All tests shall be performed in the presence of the Mechanical Consultant or the Commissioning Consultant. Complete the testing forms and forward to the Consultant.

3.8 The Independent Contractors Testing and Balancing of Air Systems

- .1 Conform with specification section 23 05 93, Testing, Adjusting and Balancing.
- .2 The Independent Contractor shall be hired by The Mechanical Contractor and shall report to the Commissioning Consultant.
- .3 TAB Contractor shall be hired within 3 months of mechanical contract award.
- .4 Within two weeks of TAB contract award, TAB Contractor shall review the spec and drawings towards TAB perspective and issue a report. Marked up drawings as a report is not acceptable.

3.9 Testing of Equipment and Systems

- .1 General
 - .1 The Mechanical Contractor shall hire the services of the manufacturers technicians to test the equipment and associated systems. The technician shall record the results of the tests on the testing forms. The tests shall be witnessed by the Consultant or the Commissioning Consultant. When the tests have been completed satisfactorily the technician and witnessing authority shall sign the forms. A copy of the forms shall be forwarded to the Consultant. The original shall be inserted into the operating and maintenance manual.
 - .2 Mechanical Contractor shall notify the start-up dates to Consultant and Commissioning Consultant atleast two weeks in advance.
 - .3 Should equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed.
 - .4 Tests which have not been witnessed shall not be accepted and shall be repeated.
 - .5 Commissioning shall be done to verify the performance of equipment in the respective seasons (summer. Winter and months) as per sequence of operations.

Commissioning

.6 The equipment and systems to be tested shall include:

- Energy Recovery Ventilators
- Ecology Unit
- Pumps
- Heat Pumps
- Life Safety and Fire Protection Systems
- Oil Handling Systems
- Fans
- Air Curtain
- Water Treatment Systems
- Building Automation Systems (BAS)
- Noise and Vibration
- Specialty Equipment

.2 BAS Testing

- .1 The BAS Contractor shall test the system as described in 23 09 33.
- .2 Co-ordinate with the Commissioning Consultant and submit completed test forms monthly
- .3 Demonstrate the operation of the BAS when all tests have been completed.
- .4 BAS Contractor shall perform point to point (PTP) verification and functional performance tests (FPT), verify the sequence of operation. BAS Contractor shall notify all the parties including the mechanical contractor, the consultant, energy management and facility operator two weeks in advance.
- .5 BAS Contractor shall repeat the tests until all the systems and equipment are operating as per the contract documents.

3.10 Commissioning Meetings and Reporting

- .1 The Mechanical Contractor shall include the schedule for all tests and equipment start-up tests in the construction schedule.
- .2 The commissioning meetings shall occur during the regular construction meetings. The testing schedules and results of all tests shall be reviewed.
- .3 All testing forms and reports associated with the mechanical systems shall be directed to the Consultant with copies to the Architect and Commissioning Consultant.

Commissioning

.4 The forms and reports to be issued shall include:

- Shop drawings, issued and accepted
- Equipment verification forms
- Testing forms
- Reports resulting from tests
- Testing schedule
- Minutes of commissioning meetings
- Equipment Start-up Forms

3.11 Operating and Maintenance Manual

- .1 Conform to section 21 05 00 for requirements for the O&M Manuals.
- .2 O & M manual shall be delivered to the Consultant and Commissioning Consultant three weeks prior to training start date.

3.12 Operator Training

- .1 Conform to section 21 05 00 for requirements for Instruction to Operating Staff.
- .2 The training shall be conducted in a classroom and at the equipment or system.
- .3 Training shall be conducted atleast in two sessions to accommodate the Owner's team schedule.
- .4 Training will begin only when all the system and equipment are satisfactorily operating and approved by the Owner and Commissioning Consultant.
- .5 Each training session shall be structured to cover:
 - The operating and maintenance manual
 - Operating procedures
 - Maintenance procedures
 - Trouble-shooting procedures
 - Spare parts required

Submit a course outline to the Mechanical Consultant before training commences. Provide course documentation for up to eight people.

- .6 The training sessions shall be scheduled and co-ordinated by the Commissioning Consultant. Video tape the training session in completely excluded from the Commissioning Consultant scope. The Mechanical Contractor shall video tape all the trainings and demonstrations.

Commissioning

.7 Training shall be provided for the following systems:

<u>System</u>	<u>Minimum Training Times</u>
MakeUp Air Unit	2 hours
Ecology Unit	2 hours
Energy Recovery Ventilators	2 hours
HVAC Pumps	2 hours
HVAC Fans	2 hours
Air Curtains	2 hours
Life Safety & Fire Protection Systems	4 hours
Water Treatment Systems	2 hours
Variable Frequency Drive	2 hours
Heat Pumps	2 hours

.8 The minimum training for the BAS shall be 40 hours. The training shall include:

- A walk through of the installation for the Building Owner to review the installation and equipment
- Operation of the central computer
- Operation of portable terminals
- Control sequences
- Report set-up and generation
- Managing the system
- Maintenance requirements
- Hard and soft reset of BAS controllers to restore network communication
- Operation of central computer
- Operation of portable terminals
- The BAS is hosted / accessed via City owned virtual server.

Refer to specification section 23 09 33 for further information.

.9 The training requirement for the mechanical system shall include a walk-through of the building by the Mechanical Contractor. During the walk through the Mechanical Contractor shall:

- Identify equipment
- Identify starters associated with equipment
- Identify valves and balancing dampers

Commissioning

- Identify access doors
 - Review general maintenance of equipment
 - Review drain points in pipework systems
 - Identify maintenance items
- .10 When each training session has been completed The Owner or the Commissioning Consultant shall sign the associated form to verify completion.

3.13 Commissioning Consultant

- .1 A Commissioning Consultant (CC) reports to the Owner.
- .2 The CC responsibilities shall include:
- preparing the commissioning plan
 - co-ordinating with the contractor to schedule tests
 - preparing a test form manual
 - witnessing selected tests
 - receiving all test forms
 - conducting performance test
 - co-ordinating the contractors training
 - chair commissioning meetings
- .3 The Mechanical Contractor shall co-operate with the CC.
- .4 The Mechanical Contractor shall provide assistance to the CC and have personnel available during the performance testing procedure. Each mechanical system shall be tested in the operational mode.
- .5 Performance testing shall begin when all systems have been completed, tested by the Mechanical Contractor and the Consultant has completed their final review.

3.14 Mechanical System Demonstration And Turnover

- .1 Refer to section 21 05 00. Mechanical Project Completion.
- .2 The system demonstration and turnover to The Owner shall occur when:
- The installation is complete
 - The acceptance test conducted by the Mechanical Consultant has been completed successfully
 - The Commissioning Consultant system performance testing has been completed successfully
 - Training has been completed
 - Operating and Maintenance Manuals have been accepted

Commissioning

- Shop-drawings have been updated
 - As-built drawings have been completed
- .3 The systems demonstration shall be conducted by the Mechanical Contractor and the manufacturers. The demonstration shall cover a demonstration of equipment installation and operation.

3.15 Testing Forms

- .1 The Mechanical Contractor and manufacturers shall fill out the forms listed in this section or provide other forms. The forms must be approved by the Consultant and The Owner before they are used.

3.16 Warranties

- .1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by The Owner.
- .2 The Mechanical Contractor shall fill out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
- .3 Refer to the general conditions specification section for the requirements during the warranty period.

3.17 Commissioning Process Allocation

- .1 The commissioning process shall be allocated a value equal to 8% of the contract. The Mechanical Contractor may draw from this allocation as the commissioning process is completed.
- .2 The Mechanical Contractor shall submit all test and verification forms. The Consultant will use these forms to calculate percentage complete.
- .3 The Contractor may claim up to 5% of the contract from this allocation leading up to performance testing. The remaining 3% shall not be paid out until the performance testing, O & M manuals and training have been completed satisfactorily.

3.18 Seasonal Verification

- .1 Mechanical Contractor and their sub-trades shall come back to the facility to perform seasonal verification. Commissioning Consultant shall witness the test.

3.19 End Of Warranty

- .1 Mechanical Contractor and their sub-trades shall come back to the facility to perform end of warranty review. Commissioning Consultant shall witness the test.

END OF SECTION

Building Automation System

PART 1 - GENERAL**1.1 General**

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 21 05 00 General Mechanical Requirements.
- .3 Conform to Energy Management Guide and Compendium April 2021 by City of Brampton.

1.2 Related Sections

- .1 Electrical Wiring: Division 26
- .2 Hydronic Specialties 23 21 14
- .3 Sequence of Operation 25 09 01
- .4 Work Provided under Division 26.
 - .1 Power at 120/1/60 will be provided for each control valve by control systems.
 - .2 Electrical interlock wiring of equipment specified under other Sections of Division 23 is responsibility of trade section installing that equipment, unless indicated otherwise.
- .5 Products Furnished but not Installed Under this Section
 - .1 Automatic control valves.
 - .2 Automatic control dampers.

1.3 System Description

- .1 Provide all controls, instrumentation and wiring as specified and required for the building management system. All devices, equipment, controllers and systems shall be native BACnet and BACnet Testing Lab (BTL) listed and shall become an extension of the existing Base energy management control system (EMCS). The controls contractor shall provide a new direct digital control (DDC) building management system (BAS) serving the building that shall seamlessly communicate on a peer-to-peer basis and provide complete interoperability.

All equipment, devices, controllers and systems shall be native BACnet® and BTL listed, not just front end equipment and at a minimum meet all of the function requirements of the B-AWS, B-BC, B-AC, B-AAC and B-ASC profiles specified in ASHRAE Standard 135-2004 Annex L.

- .2 In addition to the HVAC equipment controls, provide an open-protocol infrastructure based on BACnet, for connection of future controls work. This control system infrastructure shall include a high-speed Ethernet LAN using BACnet/IP. Operator interface to this control system infrastructure shall be web-based from any location on the BACnet/IP network.

Building Automation System

- .3 The control system will implement strategies (as per the sequences) to balance occupant comfort, equipment protection and energy consumption.
- .4 The control system shall consist of a high-speed, peer-to-peer network of DDC controllers and a web-based operator interface. Each mechanical system, building floor plan, and control device will be depicted by point-and-click graphics. A web server with a network interface card will gather data from this system and generate web pages that can be accessed through a conventional web browser on any PC connected to the network. Operators will access this system through a web browser, and the browser interface shall allow the operator to perform all normal operator functions.
- .5 The system will directly control the HVAC equipment as specified in the Sequences of Operation in 259001. Each zone controller will provide for occupied/unoccupied mode of operation by individual zone. Energy conservation features such as optimal Start/Stop, night setback, request-based logic, demand level adjustment of setpoints, etc. shall be provided.
- .6 The system shall use BACnet Ethernet (SIO 8802-3) or BACnet MS/TP protocol for all communications to the B-AWS and for all communications between control modules. All schedules, setpoints, trends, and alarms specified in the Sequences of Operation shall be BACnet objects. Other communication protocols are not acceptable.
- .7 Coordinate with divisions 23 00 00 and 26 00 00 to ensure that the control of all equipment is as specified.
- .8 Any control system, hardware, software and devices must apply for and receive an approved RFC (Request for Change) from DND 2ASG prior to installation on the DWAN. Contractors are advised that this is not a rubber stamp process and that system configuration may have to be altered. The cost of any and all changes required for RFC will be at the Contractors expense. Any system that does not meet the requirements of the RFC and receive an approved status will not be accepted for installation on the DWAN.
- .9 Acceptable Manufacturers:
 - .1 Johnson Controls Canada LP EA
 - .2 ESC Automation Inc.
 - .3 Automated Logic Canada Ltd.

1.4 Quality Assurance

- .1 Contractor/Manufacturer Qualifications
 - .1 The Installer shall have an established working relationship with the Control System Manufacturer.
 - .2 The Installer shall have successfully completed Control System Manufacturer's classes on the control system. The Installer shall present for review a record of completed training, including a list of courses and course outlines upon request.

Building Automation System

1.5 Codes and Standards

- .1 All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to receipt of bids of the following codes:
 - .1 National Electric Code (NEC)
 - .2 Uniform Building Code (UBC)
 - .3 Uniform Mechanical Code (UMC)
 - .4 ASHRAE/ANSI 135-2001: Data Communication Protocol for Building Automation and Control Systems (BACNET)

1.6 Submittals

- .1 Product Data and Shop Drawings: Meet requirements of 01600 on Shop Drawings, Product Data, and Samples. In addition, 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 been successfully reviewed for conformity with the design intent. Six (6) copies are required. All drawings shall be prepared on a CAD system that produces drawing files that are either compatible with or may be converted to AutoCAD Release 12 or higher format. Provide drawings on magnetic/optical disk. When manufacturer's cutsheets 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 be provided within 12 weeks of contract award. Submittals shall include:
 - .1 Direct Digital Control System Hardware:
 - .1 A complete bill of materials of equipment to be used indicating quantity, manufacturer, model number, and other relevant technical data.
 - .2 Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for the items listed below and other relevant items not listed below:
 - .1 Direct Digital Controller (controller panels)
 - .2 Transducers/Transmitters
 - .3 Sensors (including accuracy data)
 - .4 Actuators
 - .5 Valves
 - .6 Relays/Switches
 - .7 Control Panels

Building Automation System

- .8 Power Supply
- .9 Batteries
- .10 Operator Interface Equipment
- .11 Wiring
- .3 Points lists for each digital controller. Include termination numbers, device part numbers, signal type and number of wires required to terminate the device.
- .4 Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware.
- .5 All electronic control panels must provide proof of testing through the procedures outlined in ASHRAE Standard 135.1-2003- Method or Test for Conformance to BACnet ® and must have achieved acceptance by the BACnet ® Testing Laboratories ®.
- .2 Controlled Systems:
 - .1 A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system. All control points shall be coordinated with equipment suppliers to ensure compatibility.
 - .2 A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, it shall be labeled with the same name.
 - .3 An instrumentation list (Bill of Materials) 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.
 - .4 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. The description shall also include a list of all I/O in plain English points and software points as required by Appendix A. This list shall indicate which points are alarmed and/or trended. Each schematic shall reference a control sequence.
 - .5 A schedule for all typical control systems to specifically identify the uniqueness of each individual system.
- .3 Quantities of items submitted shall be reviewed but are the responsibility of the Contractor.
- .4 A description of the proposed process along with all report formats and checklists to be used in Part 3: "Control System Demonstration and Acceptance."
- .5 A BACnet Protocol Implementation Conformance Statement (PICS) for each type of controller and operator interface included in the submittal.

Building Automation System

- .2 Schedules:
 - .1 Within one month of contract award, provide a schedule of the work indicating the following:
 - .1 Intended sequence of work items.
 - .2 Start dates of individual work items.
 - .3 Duration of individual work items.
 - .4 Planned delivery dates for major material and equipment and expected lead times.
 - .5 Milestones indicating possible restraints on work by other trades or situations.
 - .2 Provide monthly written status reports indicating work completed, revisions to expected delivery dates, etc. An updated project schedule shall be included.
- .3 Control System Check Out & Testing Documents: Contractor to submit three (3) copies of all system check out and testing documents for approval. Submittal to include testing procedures, check out sheets for devices, programming and graphics, and a proposed schedule that includes dependencies on other trades work.
- .4 Project Record Documents: Upon completion of installation, submit three (3) copies of record (as-built) documents. The documents shall be submitted for approval prior to final completion and shall include:
 - .1 Project Record Drawings. These shall be as-built versions of the submittal shop drawings. One set of magnetic media drawing files shall also be provided, in a format compatible with or convertible to AutoCAD version 12 or higher. (.DWG, .DXF, .VSD, etc.)
 - .2 Testing and Commissioning Reports and Checklists. Completed versions of all reports and checklists, along with all trend logs, used to meet the requirements of Part 3: "Control System Demonstration and Acceptance."
 - .3 Operation and Maintenance (O&M) Manual. This shall include as-built versions of the submittal product data. In addition to the information required for submittals, the O&M manual shall include printed, electronic, or on-line help documentation of the following:
 - .1 Names, addresses, and telephone numbers of contractors installing equipment and the control systems and service representatives of each.
 - .2 Operators Manual with procedures for operating the control systems, including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables. Either printed or electronic documentation (help files or training materials) are acceptable.
 - .3 One set of Programming Manuals with a description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.

Building Automation System

- .4 Engineering, Installation, and Maintenance Manual(s) that explain how to design and install new points, panels, and other hardware; preventive maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.
 - .5 A listing and documentation of all custom software created using the programming language, including all points definition, the set points, tuning parameters, and object database. Electronic copies of the actual programs may be used for this purpose, if the control logic, set points, tuning parameters, and other objects can be viewed through the supplied programming tools. One set of magnetic/optical media containing files of the software and database also shall be provided. CAD drawings for the BAS.
 - .6 One set of magnetic/optical media containing files of all color graphic screens created for the project, if not included in the magnetic/optical media containing the software and database.
 - .7 A list of recommended spare parts with part numbers and suppliers.
 - .8 Complete original issue documentation, installation, and maintenance information for all third-party hardware provided, including computer equipment and sensors.
 - .9 Complete original issue diskettes for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
 - .10 Licenses, guarantees, and warranty documents for all equipment and systems.
 - .11 Recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions.
 - .12 A complete list of all BACnet objects (soft copy) including their ID's so that future expansion with other BACnet compliant vendors is possible.
- .5 Training Materials: The contractor shall provide a course outline and training materials for all training classes at least six weeks prior to the first class. Training shall be conducted via instructor led sessions, computer-based training, or web-based training. The Owner may modify any or all of the training course outline and training materials to meet the needs of the Owner. Review and approval by the Owner shall be completed at least three weeks prior to the first class.
- .6 Network diagram showing required data drops and data required.

Building Automation System

1.7 Warranty**.1 Warrant all work as follows:**

- .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 Owner receives beneficial use of the system. 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.
- .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 At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the Owner, the Owner shall 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.
- .4 At the end of the warranty period, the contractor will upgrade the Owner to the latest BAS software available at no cost to the Owner.
- .5 Exception: The contractor shall not be required to warrant reused devices, except for those that have been rebuilt and/or repaired. The contractor shall warrant all installation labour and materials, however, and shall demonstrate that all reused devices are in operable condition at the time of Owner's acceptance.
- .6 Contractor shall provide season adjustments over the first year of operation as required to meet system objectives.

1.8 Ownership of Proprietary Material

- .1 All project-developed software and documentation shall become the property of the Owner. These include, but are not limited to:
 - .1 Project graphic images
 - .2 Record drawings
 - .3 Project database
 - .4 Project-specific application programming code
 - .5 All documentation
- .2 The Owner shall have full ownership rights for control software which includes the ability to write and fully program control panels and stats as well as troubleshoot without the need of factory service support.

Building Automation System

1.9 Compliance with the City Energy Management Guidelines

- .1 Comply with the City Energy Management Guidelines (attached 27 pages).
- .2 In case of discrepancy between this section and the City Energy Management Guidelines the Guidelines shall be implemented.

PART 2 - PRODUCTS**2.1 Materials**

- .1 All products used in this project installation shall be new and currently under manufacture and shall be the version currently being sold by the manufacturer for use in new installations. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing. Spare parts shall be available for at least five years after completion of this contract.

2.2 Communication

- .1 All control products provided for this project shall comprise a BACnet internal network. Communication involving control components (i.e., all types of controllers and operator interfaces) shall conform to ANSI/ASHRAE Standard 135-2000, BACnet.
- .2 All controllers shall have a communication port for temporary connection to a laptop computer or other operator interface device. This connection shall support memory downloads and other operations needed for commissioning and troubleshooting.
- .3 Communication services over the internal network shall result in operator interface and value passing that is transparent to the internal network architecture as follows:
 - .1 Connection of an operator interface device to any one controller on the network will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, control algorithms, etc., for all controllers shall be available for viewing and editing from any one controller on the internal network. Primary panel must be capable of communication over a fibre optic TCPIP network. Provide conduit and twisted pair CAT 6 cable from main B-BC building control panel to COMMS room for connection to Base DWAN.
 - .2 All inputs, outputs, and other control parameters used to integrate control strategies across multiple controllers shall be readable by any other controller on the internal network. All links required to execute the control strategies described in Annex A shall be programmed and tested by the contractor. An operator with appropriate password privileges shall be able to edit these links by either typing in a standard object address or using a simple point and click interface.
- .4 The time clocks in all controllers shall be automatically synchronized daily via the internal network. An operator change to the master time clock shall be automatically broadcast to all controllers on the internal network.

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- .5 The internal network shall be compatible with Dimax and shall have the following minimum capacity for future expansion:
 - .1 Each router or building controller/router on the network backbone shall have routing capacity for 50 controllers.
 - .2 The network backbone shall have capacity for 50 routers or building controller/routers.
 - .3 The system shall have an overall capacity for 12,500 building controller, custom application controller, and application specific controller input/output objects. System shall be compatible with existing BAS.

2.3 Controller Software

- .1 Furnish the following applications software for building and energy management. All software applications shall reside and operate in the system controllers. Editing of applications shall be done through the operator workstation/browser interface or at other engineering workstations. (See paragraph 2.3 D for a list of the functions that must be available through the operator workstation or browser.)
- .2 System Security
 - .1 User access shall be secured using individual security passwords and user names.
 - .2 Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager. The system supervisor shall also have the ability to vary the functions accessible to each user depending on the equipment or geographic location, and to restrict an operator to only viewing and/or editing certain areas or pieces of equipment.
 - .3 User Log On/Log Off attempts shall be recorded.
 - .4 The system shall protect itself from unauthorized use by automatically logging off if there is a period of no activity following the last keystroke. The delay time between the last keystroke and automatic logoff shall be user-definable.
- .3 Scheduling. Provide the capability to schedule each object or group of objects in the system. Scheduling options shall include the following:
 - .1 Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules shall include up to five start/stop pairs. (10 events)
 - .2 Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule has executed, it will be discarded and replaced by the standard schedule for that day of the week.
 - .3 Holiday Schedules. Provide the capability for the operator to define up to 24 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

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- .4 System Coordination. Provide a standard application for the proper coordination of equipment. This application shall provide the operator with a method of grouping together equipment based on function and location. This group may then be used for scheduling and other applications.
- .5 Binary Alarms. Each binary input and binary value object shall be capable of generating an alarm based on an operator-specified state. Provide the capability to enable or disable this alarm. The system shall be delivered with alarms enabled as listed in the Sequence of Operations.
- .6 Analog Alarms. Each analog object shall be capable of generating an alarm based on an operator-specified high and low alarm limit. . Provide the capability to enable or disable this alarm. The system shall be delivered with alarms enabled as listed in the Sequence of Operations.
- .7 Alarm Reporting. The operator shall be able to configure the actions the system will take when an alarm is received as described under section 2.3.E.9 of this specification.
- .8 Remote Communication. The system shall have the ability to automatically contact an operator workstation or server when a critical alarm is received, using either a network connection or, if no network connection is available, a dial out connection over a modem.
- .9 Demand Limiting.
 - .1 The system shall be capable of monitoring power consumption from signals generated by a pulse generator (provided by others) mounted at the building power meter or from a watt transducer or current transformer attached to the building feeder lines.
 - .2 If the power consumption exceeds operator definable levels, the system shall be capable of automatically adjusting setpoints, de-energizing low priority equipment, and taking other pre-programmed actions as described in the Sequence of Controls to reduce demand. As the demand drops below the operator defined levels, action will be taken to restore loads in a predetermined manner.
 - .3 The system will be set up with three (3) stages of demand limiting that are manually activated by the system operator. Activation will be through a graphical button on the demand limiting screen. Manual limiting is to be used when there is no interface to electrical metering to allow the operator to manually load shed the building to conserve energy.
- .10 Maintenance Management. The system shall be able to monitor equipment status and generate maintenance alarms based upon user-designated run-time, starts, or performance limits. The system shall be configured to deliver maintenance alarms based upon the Sequences of Operation.
- .11 Sequencing. Provide application software based upon the sequences of operation specified to properly sequence HRU, heat pumps and pumps.

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- .12 PID Control. A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, set point, and PID gains shall be user-selectable.
- .13 Staggered Start. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user-selectable.
- .14 Energy Calculations.
 - .1 Provide software to allow instantaneous power (e.g., kW) or flow rates (e.g., L/s [gpm]) to be accumulated and converted to energy usage data.
 - .2 Provide an algorithm that calculates a sliding window average (e.g., rolling average). The algorithm shall be flexible to allow window intervals to be user specified (e.g., 15 minutes, 30 minutes, 60 minutes).
 - .3 Provide an algorithm that calculates a fixed-window average. A digital input signal will define the start of the window period (e.g., signal from utility meter) to synchronize the fixed-window average with that used by the utility.
- .15 Anti-Short Cycling. All binary output objects shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.
- .16 On/Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and set point. The algorithm shall be direct-acting or reverse-acting and incorporate an adjustable differential.
- .17 Run-Time Totalization. Provide software that can totalize run-times for any binary input or object. A high runtime alarm shall be assigned, if required, by the operator. The system shall be delivered with run time totalization and alarms configured as specified in the Sequence of Operations.
- .18 Trending

2.4 Building Controllers

- .1 General. Provide Building Controllers (BC) as required to achieve the performance specified. Each of these controllers shall meet the following requirements.
 - .1 The building controller shall have sufficient memory to support its operating system, database, and programming requirements.
 - .2 Data shall be shared between networked building controllers.
 - .3 The operating system of the building controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
 - .4 Controllers that perform scheduling shall have a real-time clock.
 - .5 The building controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall generate an alarm notification.

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- .6 The Building Controller shall comply with all required aspects of the BACnet Building Controller (B-BC) device profile as outlined in Annex L of the current ASHRAE/ANSI BACnet Standard.
- .2 Communication.
 - .1 Each building controller shall reside on or be connected to a BACnet network using the BACnet Ethernet or BACnet MS/TP protocol. Either the building controllers or separate BACnet Device Routers shall perform BACnet routing if necessary to connect to networks of custom application and application specific controllers.
 - .2 The controller shall provide a service communication port for connection to a portable operator's terminal.
- .3 Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
 - .1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
 - .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).
- .4 Keypad. A local keypad and display or a connection for a portable operator terminal shall be provided for each controller. The keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display. If the manufacturer does not provide this keypad and display, provide a portable operator terminal.
- .5 Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
- .6 Memory. The building controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
- .7 Immunity to power and noise. Controller 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).
- .8 Uninterruptible Power Supply
 - .1 An Uninterruptible Power Supply shall be provided and installed by this Contractor for each of the Integrated Automation System panels.
 - .2 Each UPS shall power the complete panel, and any equipment server power from that panel, for a minimum of 30 minutes, in the case of power interruption.
 - .3 The UPS shall be an on-line type and shall transfer from normal to battery power, and back, seamlessly.
 - .4 The UPS shall emit a purely sinusoidal power waveform.
 - .5 The batteries shall be of the totally enclosed type. Batteries that can leak gas shall not be acceptable.

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- .6 There shall not be any damages should the emergency outage of line power exceed the maximum operation time of the UPS.

2.5 Advanced Application Controllers

- .1 General. Provide Advanced Application Controllers (AAC) as required to achieve the performance specified in the Part 1 Article on "System Performance." Each of these controllers shall meet the following requirements.
 - .1 The advanced application controller shall have sufficient memory to support its operating system, database, and programming requirements.
 - .2 Data shall be shared between networked advanced application controllers.
 - .3 The operating system of the controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms.
 - .4 Controllers that perform scheduling shall have a real-time clock.
 - .5 The advanced application controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall generate an alarm notification.
 - .6 The controller shall comply with all required aspects of the BACnet Advanced Application Controller (B-AAC) device profile as outlined in Annex L of the current ASHRAE/ANSI BACnet Standard.
- .2 Communication
 - .1 Each advanced application controller shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - .2 The controller shall provide a service communication port for connection to a portable operator's terminal.
- .3 Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
 - .1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
 - .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).
- .4 Keypad. A local keypad and display or a connection for a portable operator terminal shall be provided for each controller. The keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display. If the manufacturer does not provide this keypad and display, provide a portable operator terminal.
- .5 Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

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- .6 Memory. The building controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
- .7 Immunity to power and noise. Controller 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).

2.6 Application Specific Controllers

- .1 General: Provide Application Specific Controllers (ASC) as required to achieve the performance specified in the Part 1 Article on "System Performance." Each of these controllers shall meet the following requirements.
 - .1 Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
 - .2 Each ASC will contain sufficient I/O capacity to control the target system.
 - .3 The controller shall comply with all required aspects of the BACnet Application Specific Controller (B-ASC) device profile as outlined in Annex L of the current ASHRAE/ANSI BACnet Standard.
- .2 Communication.
 - .1 The controller shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol. Each network of controllers shall be connected to one building controller.
 - .2 Each controller shall have a connection for a laptop computer or a portable operator's tool. This connection shall be extended to a space temperature sensor port where shown.
- .3 Environment. The hardware shall be suitable for the anticipated ambient conditions.
 - .1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
 - .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).
- .4 Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
- .5 Memory. The application specific controller shall use nonvolatile memory and maintain all BIOS and application programming in the event of a power loss.
- .6 Immunity to power and noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

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- .7 Transformer. Power supply for the ASC must be rated at a minimum of 125% of ASC power consumption and shall be of the fused or current limiting type.

2.7 BACNET Lighting Controller

BAS shall be integrated with lighting controller provided by Division 26.

~~.1 Product Requirements. The Building Automation System Contractor shall supply and install lighting controllers as a component of a complete low voltage lighting control system as required to accomplish the specified Sequences of Operation and as indicated in the project documentation, plans, specifications, and schedules. Refer to electrical drawings for detailed information regarding lighting layout and control. Provide all necessary material, labour, testing to comply with lighting control requirements as per ASHRAE 90.1 for a fully operational system. The BAS shall provide full integration with the Lighting Control System provided by Division 26. Coordinate with Division 26 for all details and implementation related to integration.~~

~~.1 All networked, microprocessor-based components of the low voltage lighting control system including lighting controllers, BACnet devices, operator displays, and supervisory software as provided and installed under this specification shall be from a single manufacturer and product line or product family.~~

~~.1 All networked, microprocessor-based components of the low voltage lighting control system shall be provided by the manufacturer of any Building Automation System components being provided as a part of this project.~~

~~.2 The lighting controller manufacturer product line selected shall be the most current and complete offering and shall be actively manufactured and supported.~~

~~.1 This project shall not be used as a test site. First release and test version hardware, and firmware shall not be implemented on this project under any circumstances.~~

~~.3 The entirety of the lighting controller product line selected shall be designed and deployed specifically with standard provisions for integral backwards compatibility and extensibility.~~

~~.1 The lighting controller manufacturer shall certify that the controllers and spare or equivalent components shall be readily available for a minimum of five (5) years after the completion and final acceptance of this project.~~

~~.2 The lighting controller manufacturer shall certify that its own product line in its entirety, and as was in mainstream service, ten (10) years prior to the bid date for this project are still supported. Support shall include complete viability and compatibility of the legacy components with the current mainstream product line, as well as availability of replacement or equivalent compatible components and/or repair services.~~

~~.3 OEM and/or private-labelled controllers manufactured or developed by a third-party and labelled or otherwise represented as being a product of the lighting controller manufacturer shall not be accepted under this specification.~~

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- ~~.4 Non-networked system components specified in this section (including sensors, switches, fixtures, etc.) need not be manufactured by the lighting controller manufacturer.~~
- ~~.4 Related Sections. Lighting controllers must comply with the requirements of this specification including other relevant specification sections (when not in conflict with this section) including the following at a minimum:
 - ~~.1 Division 01~~
 - ~~.2 Section 26 50 00 Lighting.~~
 - ~~.3 Section 26 53 00 Emergency Lighting.~~
 - ~~.4 Section 26 05 00 Basic Materials & Methods — Surface Raceways for Communications Systems.~~~~
- ~~.5 Codes and Standards. Workmanship, materials and equipment together with the resultant complete and operational lighting controllers and corresponding lighting control panels shall comply with the Authorities Having Jurisdiction (AHJ) for the project and the most restrictive of applicable local, state, and federal codes and ordinances in cooperation with these plans and specifications. At a minimum, the installation shall comply with the current editions in effect thirty (30) days prior to receipt of bids of the following applicable codes:
 - ~~.1 ANSI/ASHRAE Standard 135: BACnet — A Data Communication Protocol for Building Automation and Control Networks.~~
 - ~~.2 National Fire Protection Association (NFPA) 70: National Electric Code (NEC).~~
 - ~~.3 Canadian Electrical Code, Part 1 (CSA C22.1-12).~~
 - ~~.4 International Building Code (IBC).~~
 - ~~.5 International Mechanical Code (IMC).~~
 - ~~.6 Underwriters Laboratories: UL-20 — General Use Snap Switches (CSA22.2 No. 411).~~
 - ~~.7 Underwriters Laboratories: UL-916 — Energy Management Systems (EMS).~~
 - ~~.8 Underwriters Laboratories: UL-924 — Safety of Emergency Lighting and Power Equipment.~~
 - ~~.9 Conformité Européenne (CE).~~~~
- ~~.6 Quality Assurance. The Building Automation System Contractor shall be responsible for quality assurance of the lighting controllers.
 - ~~.1 The Building Automation System Contractor shall specialize in the design, installation, programming, and operation of systems consistent with the scope, size, and service specified.~~
 - ~~.2 The Building Automation System Contractor shall be an officially authorized representative of the lighting controller manufacturer with an established relationship of not less than three (3) years.~~~~

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- ~~.3 The Building Automation System Contractor shall assign to the project technicians and engineers who are officially trained and certified by the lighting controller manufacturer in the design, installation, programming, and operation of the System components.~~
- ~~.4 The lighting controller manufacturer shall be engaged full-time in the manufacture of equipment and devices of the scope, size, and service consistent with the requirements for this project.~~
- ~~.5 The lighting controller manufacturer shall operate a Quality Management System that is formally certified to be in compliance with ISO 9001:2015.~~
- ~~.6 The lighting controller manufacturer shall operate an Environmental Management System that is formally certified to be in compliance with ISO 14001:2015.~~
- ~~.7 Lighting controllers provided under this specification must be manufactured in compliance with Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronics equipment (RoHS 2).~~
- ~~.8 The lighting controller shall be based upon, and installed according to, the manufacturer's standard integrated hardware and software product design and in accordance with the manufacturer's installation and application documentation.~~
- ~~.2 BACnet®. Each lighting controller as provided and installed under this specification shall be an integrated component of a multitiered, high speed, peer to peer internetwork of ANSI/ASHRAE Standard 135 native BACnet devices.~~
 - ~~.1 All communication between lighting controllers and Building Automation System devices, including operator workstation and operator display communication, provided and/or installed under this specification shall conform to ANSI/ASHRAE Standard 135, BACnet using native BACnet communications.~~
 - ~~.1 All network lighting control devices shall utilize a native BACstack embedded at the media access controller level.~~
 - ~~.2 Lighting control devices that require translation of data, gateways, or mapping of any kind for communication between devices connected to the internetwork shall not be acceptable.~~
 - ~~.3 The lighting control system shall also incorporate non-networked, non-communicating input/output devices, mechanical/electrical automatic lighting control devices, enclosures, interconnecting conduit and cabling.~~
- ~~.3 BTL. All lighting controllers provided and installed under this specification shall be tested, certified, clearly stamped and listed by the BACnet Testing Laboratories (BTL) a minimum of 30 days prior to the bid date for this project.~~
 - ~~.1 BTL product listings are available from BACnet International (<http://www.bacnetinternational.net/btl/>).~~

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- ~~.4 BACnet Device Profile. Lighting controllers shall be certified and Listed by the BACnet Testing Laboratories (BTL) in compliance with the minimum requirements of ANSI/ASHRAE Standard 135-2012 Revision 14 Annex L a minimum of 30 days prior to the bid date for this project as follows:~~
- ~~.1 BACnet Building Controller (B-BC) ; and~~
 - ~~.2 BACnet Lighting Device (B-LD).~~
- ~~.5 BACnet Networking. Lighting controllers shall natively support the following BACnet data links as specified in ANSI/ASHRAE Standard 135 and in compliance with the following physical layer standards at a minimum:~~
- ~~.1 Master Slave Token Passing (MS/TP): ANSI/ASHRAE Standard 135.9.~~
 - ~~.1 TIA-485.~~
- ~~.6 EnOcean® Networking. Lighting controllers shall support the EnOcean interoperable communication protocol.~~
- ~~.1 All wireless components shall be manufactured by a member of the EnOcean® Alliance.~~
 - ~~.2 Wireless components that utilize communication protocols other than EnOcean shall not be acceptable.~~
 - ~~.3 All wireless components shall comply with the following communication specifications:~~
 - ~~.1 Standards: FCC CFR 47 Part 15 Class B (TCM 300C, TCM 300U).~~
 - ~~.2 Transceiver frequency: 868 MHz or 902 MHz.~~
 - ~~.3 Data rate/modulation type: 125 kbps/ASK, 868 Mhz; FSK, 902 Mhz.~~
 - ~~.4 Receiver sensitivity (@25°C): 98 dB (868 MHz, 902 Mhz).~~
- ~~.7 Extensibility. The lighting controllers shall be modular in nature and implemented in such a manner that the lighting control system can be expanded in functionality and in capacity to at least twice the required hardware through the addition of controllers, devices, and wiring.~~
- ~~.1 Expansion shall not require operator interface hardware additions, software revisions, firmware revisions, or additional licensing.~~
- ~~.8 Environment. All lighting controllers shall be suitable for permanent installation in conditioned spaces and shall be rated for operation at -20°C to 55°C (-4°F to 131°F).~~
- ~~.1 All controllers shall be suitable for permanent installation in the design location and ambient conditions.~~
 - ~~.2 Controllers shall not be installed outdoors or in wet conditions.~~
- ~~.9 Power & Noise. All lighting controllers shall be able to operate at 90% to 110% of the nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.~~
- ~~.1 Controllers shall be certified in compliance with FCC/ICES 003 CFR47 Part 15/B.~~
- ~~.10 Serviceability. All lighting controllers shall be provided with diagnostic LEDs to indicate power, communication, and processor status.~~

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- ~~.11 Memory. All lighting controllers shall have sufficient memory to support the operating system, database, and programming necessary to satisfy the specified Sequence of Operation and to comply with the requirements of all applicable System specifications.~~
 - ~~.1 Battery/capacitor shall maintain runtime values and clock memory following a loss of power for a minimum of 72 hours.~~
 - ~~.2 The database and programming shall be maintained without power for a minimum of 10 years.~~
 - ~~.3 All application programs shall be stored on individual controllers in non-volatile memory.~~
- ~~.12 Workstation Port. Each lighting controller shall provide a communication port for the connection of an operator workstation.~~
- ~~.13 Inputs. Lighting controllers shall be provided with a minimum of four (4) universal inputs dedicated for the connection of field devices and shall support at a minimum the following physical characteristics:~~
 - ~~.1 Thermistor.~~
 - ~~.2 Dry contact.~~
 - ~~.3 Current (4-20 mA).~~
 - ~~.4 Voltage (0-10 VDC).~~
 - ~~.5 40 Hz pulse counting.~~
 - ~~.6 12-bit A/D resolution.~~
 - ~~.7 24 VAC over voltage protection.~~
- ~~.14 Outputs. Lighting controllers shall be provided with physical outputs dedicated for the connection of lighting relays, low-voltage lighting fixtures, field devices, etc. and shall support at a minimum the following physical characteristics:~~
 - ~~.1 Universal Outputs.~~
 - ~~.1 0-12 VDC; 75 mA @ 12 VDC.~~
 - ~~.2 Sink and source.~~
 - ~~.3 12-bit D/A resolution.~~
 - ~~.4 24 VAC over voltage and short protection.~~
 - ~~.2 Relay Driver Outputs.~~
 - ~~.1 500 mA @ 24 VAC.~~

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- ~~.15 Database. All lighting controller programming, configuration, and modification shall be accomplished via the BACnet internetwork from a B-AWS. The complete operational database and application program shall reside in each individual controller.~~
- ~~.1 Each lighting controller shall provide microprocessor based, self-contained, stand-alone, fully-programmable operation of local process control loops.~~
- ~~.2 All lighting controllers shall function in a real-time, multitasking, networked operating environment; able to display database values, programs, and control loops in real-time while functional and simultaneously available to the operator online from the B-AWS, B-OWS, or B-OD.~~
- ~~.16 Programmability. All lighting controllers shall be freely programmable and support custom control strategies, programs, scenes, zones, and databases that are completely modifiable over the BACnet internetwork once installed.~~
- ~~.1 All lighting controllers delivered as a part of this specification shall be programmed using one (1) common programming language, means, and method via the B-AWS or enterprise B-OWS. Devices that require separate custom applications for programming shall not be acceptable.~~
- ~~.2 Application specific and/or configurable devices are strictly prohibited.~~
- ~~.17 Schedules. All lighting controllers shall support the standard BACnet Schedule and BACnet Calendar objects.~~
- ~~.1 Schedule objects shall reside in each individual device.~~
- ~~.2 Applications requiring schedule objects and/or parameters to be stored exclusively on a workstation or server shall be strictly prohibited.~~
- ~~.3 All lighting controllers shall support binary, analog, and multi-state BACnet Schedule objects.~~
- ~~.18 Trend Logs. All lighting controllers shall locally perform and manage historical data collection.~~
- ~~.1 All lighting controllers shall support:~~
- ~~.1 The BACnet Trend Log object.~~
- ~~.2 The BACnet Trend Log Multiple object.~~
- ~~.3 Change Of Value (COV) trending.~~
- ~~.2 All trend log data shall be stored in non-volatile memory and be preserved through loss of power.~~
- ~~.3 All objects (both hardware and software) system-wide shall be assignable to user-definable trend logs with configurable sample rates and length.~~
- ~~.4 Trend log data shall be stored at each individual lighting controller and uploaded to hard disk storage by a BTL Listed BACnet device dedicated for this service when long-term archiving is required.~~

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~~.5 Runtime Logs. All lighting controllers shall support logging and reporting of runtime for every binary object.~~

~~.1 Runtime data shall be sampled and stored in each individual BACnet lighting controller using standard BACnet objects and published properties. A workstation shall not be required for storage of custom runtime logs.~~

~~.19 Communicating Sensors. All lighting controllers shall support and be capable of monitoring and controlling a network of communicating sensors without consuming physical hardware input/output points on the device.~~

~~.1 A minimum of four (4) communicating sensors shall be supported by each lighting controller.~~

2.8 Input/Output Interface

- .1 Hardwired inputs and outputs may tie into the system through building controllers, advanced application controllers, application specific controllers, or smart actuators
- .2 All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to the controller.
- .3 Binary inputs shall allow the monitoring of On/Off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
- .4 Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.
- .5 Analog inputs shall allow the monitoring of low-voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor or RTD). Analog inputs shall be compatible with - and field configurable to - commonly available sensing devices.
- .6 Binary outputs shall provide for On/Off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building controllers shall have three-position (On/Off/Auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.
- .7 Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on building controllers shall have status lights and a two position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.
- .8 Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (fan coil units, duct-mounted heating coils, zone dampers, radiation, etc.).

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- .9 Input/Output points may be of a universal type, i.e., controller input or output may be designated (in software) as either a binary or analog type point with appropriate properties. Application specific controllers are exempted from this requirement.
- .10 System Object Capacity. The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions software revisions in order to expand the system.

2.9 Power Supplies and Line Filtering

- .1 Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
 - .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 a 150% current overload for at least three seconds without trip-out or failure.
 - .1 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.
 - .2 Line voltage units shall be UL recognized and CSA approved.
 - .2 Power line filtering.
 - .1 Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:
 - .1 Dielectric strength of 1000 volts minimum
 - .2 Response time of 10 nanoseconds or less
 - .3 Transverse mode noise attenuation of 65 dB or greater
 - .4 Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.

2.10 Auxiliary Control Devices

- .1 Filter Switch
 - .1 Provide filter switches as indicated on the drawings. If not shown on drawings switches to be provided based on the following:
 - .1 Each filter bank in all air handling units so that individual filters can have unique dirty/clean setpoints.

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- .2 Switches to have adjustable setpoints between 12 Pa to 1250 Pa (0.05 to 5 in. w.g.).
- .3 Setpoints to be initially set up to suit the applicable filter.
- .4 Switch to come with a SPDT contact.
- .5 Standard of Acceptance:
 - .1 Penn
 - .2 Honeywell
 - .3 Siemens
- .2 Control Panels
 - .1 Provide control panels as required for the building automation system.
 - .2 All indoor control cabinets shall be fully enclosed construction with (hinged door) key-lock latch and removable sub-panels. A single key shall be common to all field panels and sub-panels.
 - .3 All outdoor panels to be NEMA 4 construction.
 - .4 Interconnections between internal and face mounted devices shall be pre-wired with colour coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
 - .5 Provide ON/OFF power switch with over current protection for control power sources to each local panel.
 - .6 Panels to be labelled in accordance with section 3.13.
 - .7 Provide 120 VAC outlet near all major panels.
- .3 Current Switch
 - .1 Provide current switches as indicated on the drawings. If not shown on drawings current switches to be provided based on the following:
 - .1 For all motors to indicate run status.
 - .2 Provide dry contact output to BAS.
 - .3 Provide switch with amp rating to suit motor current.
 - .4 Acceptable Products:
 - .1 Greystone
 - .2 Veris
- .4 Damper Actuators
 - .1 Provide actuators as shown on the plans and specifications.
 - .2 Actuators shall be sized based on the damper manufacturer's torque ratings. Size actuators to include 15% excess torque.

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- .3 Provide spring return and non-spring return actuators as required for the project. All spring return actuator must return to their normal position within 15 seconds of losing power.
- .4 All actuators are to be spring return with the exception of actuators for zone equipment (VAV boxes etc), which can be non-spring return.
- .5 All fail safe actuators must utilize a self centering clamp on the damper shaft to eliminate elliptical travel and subsequent wear on the actuator and damper hardware.
- .6 Gear lubrication must be a silicon free material.
- .7 Auxiliary switches shall be provided to indicate damper position as required. Auxiliary switches shall be independently adjustable and switchable from 20 to 90% of stroke. Each switch must be single pole, double throw. Each actuator requiring auxiliary (end switches) shall be supplied with a redundant switch to be used in case the other switch fails.
- .8 Actuators must have electronic overload protection. Actuators must be able to detect a blockage in the damper and withstand a continuous stall condition without premature failure or downgrade in performance. When a stall is detected, the actuator must provide full torque to overcome the stall, if after a short period of time the stall is still in place the actuator must hold its position and not continue to drive and prematurely wear out the motor. If the actuator is not capable of this logic on its own it must be programmed via the DDC panel.
- .9 All actuators shall be supplied with a brightly coloured position indicator. Indicator must be viewable from 15 feet away.
- .10 All actuators must allow for manual positioning in case of power failure. Upon the resumption of power the actuator must automatically release from its manual positioning and return to control via the control signal supplied from the controller.
- .11 All modulating actuators (0-10v, 2-10v, 4-20mA) shall include separate terminals to provide a position feedback signal that can be used to determine the position of the damper for troubleshooting purposes.
- .12 Actuators must be UL 873 and CSA22.2 listed.
- .13 Acceptable Products:
 - .1 Siemens
 - .2 Belimo
 - .3 Johnsons
- .5 Control Relay
 - .1 Provide UL listed DPDT relays as required for the BAS.
 - .2 Relays to have indicating lights to show on/off status.
 - .3 Contacts to be rated for the application.

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- .4 Acceptable Products:
 - .1 Omron
 - .2 Gavazzi
 - .3 Greystone

- .6 Duct Probe Sensors
 - .1 Provide duct probe sensors for single point monitoring as indicated on the drawings. If not shown on drawings duct probes to be provided based on the following:
 - .1 Duct area is less than 1 m² (11 ft²).
 - .2 Duct area is greater than 1 m² and air temperature throughout the duct is uniform.
 - .3 Single point temperature is desired.
 - .2 Sensors to be thermistor.
 - .3 Thermistor drift not to exceed 0.1°C (0.18°F) over a 10 year period.
 - .4 Thermistor shall be provided so that the BAS reading is accurate to 0.5°C (0.9°F).
 - .5 Duct probe shall be 6.35mm (0.25") stainless steel.
 - .6 Acceptable Products:
 - .1 Greystone
 - .2 Minco
 - .3 Johnson Controls

- .7 Outdoor Air Sensor
 - .1 Provide outdoor air temperature sensors for monitoring as indicated on the drawings. If not shown on drawings sensors to be provided based on the following:
 - .1 One sensor wired to the heating plant controller.
 - .2 Once sensor for air handling unit outdoor air comparison, if no other outdoor air sensors exist.
 - .2 Sensors to be resistive temperature devices (RTD) or thermistor.
 - .3 Thermistor drift not to exceed 0.1°C (0.18°F) over a 10 year period.
 - .4 Thermistor shall be provided so that the BAS reading is accurate to 0.5°C (0.9°F).
 - .5 Sensor shall be made of PVC and have a sun and windscreen. Sensor shall be weatherproof.
 - .6 Sensor shall be mounted on north facing wall. Owner to verify exact location.

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- .7 Acceptable Products:
 - .1 Greystone
 - .2 Minco
 - .3 Johnson Controls
- .8 Immersion Sensor
 - .1 Provide immersion sensors as indicated on the drawings. If not shown on the drawings immersion sensors shall be provided as follows:
 - .1 150 mm (6") sensors on all pipe that is 150 mm or bigger.
 - .2 100 mm (4") sensors on all pipe that is between 50 mm (2") and 150 mm (6").
 - .2 Sensors to be thermistor.
 - .3 Thermistor drift not to exceed 0.1°C (0.18°F) over a 10 year period.
 - .4 Thermistor shall be provided so that the BAS reading is accurate to 0.5°C (0.9°F).
 - .5 Provide brass or stainless steel wells.
 - .6 Provide thermal grease to aid in temperature sensing.
 - .7 Acceptable Products:
 - .1 Greystone
 - .2 Minco
 - .3 Johnson Controls
- .9 Control Valves
 - .1 Provide valves as shown on the plans and specifications. Control valves shall be three-way type for modulating service.
 - .2 Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - .1 Water Valves:
 - .1 Two-way: 150% of total system (pump) head.
 - .2 Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
 - .2 Steam Valves: 150% of operating (inlet) pressure.
 - .3 Water Valves:
 - .1 Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown.
 - .2 Valves to be globe style with equal percentage characteristics for modulating services below a required CV of 400. For a CV of over 400 use butterfly valves. Ball valves are acceptable for modulating services provided they exhibit equal percentage characteristics.

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- .3 Valve to be full port ball or butterfly valves for two position services.
- .4 Sizing Criteria:
 - .1 Two-position service: Line size. Butterfly valves larger than 6" may be sized one pipe size below line size.
 - .2 Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 5 psi, whichever is greater.
 - .3 Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 35 kPa (5 psi) maximum.
 - .4 Valves ½ in. through 2 in. shall be screwed bronze body or cast brass ANSI Class 250, spring-loaded, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless steel ball. Valves to meet ANSI B16.15 requirements.
 - .5 Valves 2½ in. and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing. Valves to meet ANSI B16.1 requirements.
- .5 All valves shall be spring return with the following exceptions.
 - .1 Zone valves to fail to last position (no spring return).
 - .2 Butterfly valves to fail to last position (no spring return).
- .6 Water and glycol heating to fail open, chilled water to fail closed and domestic water heat exchanger valves to fail closed.
- .4 Valve actuators located indoors shall have NEMA 1 enclosures.
- .5 Valve actuators located outdoors shall have enclosures rated for outdoors service and heaters.
- .6 Position indicators (digital or analog) shall be provided for valves as shown on the drawings.
- .7 Valves with a CV greater than 1 shall have a 100:1 turn down ratio for increased controllability.
- .8 Valves with a CV less than or equal to 1 shall have a 50:1 turn down ratio.
- .9 Acceptable manufacturers:
 - .1 Siemens
 - .2 Belimo
 - .3 Johnson Controls
 - .4 Warren Valves
 - .5 Honeywell
 - .6 Approved Alternate

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.10 Acceptable Products: for butterfly valves:

- .1 Bray, Series 30/31
- .2 Crane
- .3 Toyo
- .4 Keystone
- .5 Approved Alternate

.11 Motorized Dampers

- .1 Low Leakage Dampers shall be extruded aluminum Tamco air foil dampers series 1000 as manufactured by T.A. Morrison with features as follows:
 - 1% leakage at 1 kPa (4") static pressure differential.
 - 12 ga. extruded aluminum airfoil single unit internally reinforced blades with continuous extruded overlapping vinyl seals.
 - 12 ga. extruded frame with extruded vinyl seals on all sides.
 - Out-of-airstream aluminum alloy linkages and crank arms with celcon bearings.
 - Celcon and polycarbonate bearings with no metal to metal contact.
 - Sized for "flanged" installation (damper blade area to be equal to duct cross sectional area).
 - Dampers shall be spring return.

2.11 Wiring and Raceways

- .1 General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 26.
- .2 All insulated wire to be copper conductors, UL labelled for 90°C minimum service.

2.12 User Interface

- .1 The bas shall be connect to the existing City Server as part of this project. Servers shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of standard data base platforms as located on the existing City Server. The City shall provide the Ethernet drop in the mechanical room to facilitate the server connection over the City wide network. A local static IP address is also required for the site main controller and is to be provided by the City IT department.

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PART 3 - EXECUTION**3.1 Examination**

- .1 The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Owner for resolution before rough-in work is started.
- .2 The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Owner for resolution before rough-in work is started.
- .3 The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate - or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others - the contractor shall report these discrepancies to the Owner and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by - and at the expense of - this contractor.

3.2 Protection

- .1 The contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.
- .2 The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 Coordination

- .1 Site
 - .1 Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
 - .2 Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.
- .2 Submittals. Refer to the "Submittals" article in Part 1 of this specification for requirements.
- .3 Test and Balance
 - .1 The contractor shall furnish to the Test and Balance Contractor a single set of all tools necessary to interface to the control system for test and balance purposes.
 - .2 The contractor shall provide training to the Test and Balance Contractor in the use of these tools. This training will be planned for a minimum of 4 hours.

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- .3 In addition, the contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
- .4 The tools used during the test and balance process by the Test and Balance Contractor will be returned in good working condition at the completion of the testing and balancing.
- .4 Life Safety
 - .1 Duct smoke detectors required for air handler shutdown are provided under Division 26 of this specification. Division 26 will interlock the smoke detectors with the air handling units.
 - .2 Smoke dampers and actuators required for duct smoke isolation are provided under Division 23. Division 26 will wire and control these dampers.
 - .3 Fire/smoke dampers and actuators required for fire rated walls are provided under Division 23. Control of these dampers shall be by Division 26.
- .5 Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or integrated into the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:
 - .1 All communication media and equipment shall be provided as specified in Part 2, "Communication" of this specification.
 - .2 Each supplier of a controls product is responsible for the configuration, programming, startup, and testing of that product to meet the sequences of operation described in this section regardless of where within the contract documents those products are described.
 - .3 The contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.

3.4 General Workmanship

- .1 Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- .2 Provide sufficient slack and flexible connections to allow for vibration isolation of piping and equipment.
- .3 Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).
- .4 Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- .5 All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
- .6 All control wiring shall be in conduits.

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3.5 Field Quality Control

- .1 All work, materials, and equipment shall comply with the rules and regulations of applicable local, provincial, and national codes and ordinances as identified in Part 1 of this specification.
- .2 Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
- .3 Contractor shall have work inspected by local and/or state authorities having jurisdiction over the work.

3.6 Wiring

- .1 All control and interlock wiring shall comply with national and local electrical codes and Division 260000 of this specification. Where the requirements of this section differ from those in Division 260000, the requirements of this section shall take precedence.
- .2 Provide all 120V and 24V power wiring to control panels and devices as required. 120V power to be obtained from designated emergency circuits provided by division 16.
- .3 All NEC Class 1 (line voltage) wiring shall be UL Listed in conduit.
- .4 All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.)
- .5 Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL Listed for the intended application. For example, cables used in ceiling plenums shall be UL Listed specifically for that purpose.
- .6 All wiring shall be installed in conduit. Minimum conduit size shall be 25 mm. Maximum conduit capacity shall be 60%. All conduits except Network Conduit shall have a pull string left in place.
- .7 Do not install Class 2 wiring in conduit 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).
- .8 Where plenum cables are used, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- .9 All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- .10 All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- .11 All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- .12 Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.

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- .13 Size of conduit and size and type of wire shall be the responsibility of the contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
- .14 Include one pull string in each conduit 2.5 cm (1 in.) or larger.
- .15 The Contractor shall terminate all control and/or interlock wiring related to the scope of work of this section and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- .16 Flexible metal conduit and liquid-tight shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal conduit less than ½ in. electrical trade size shall not be used. In areas exposed to moisture liquid-tight, flexible metal raceways shall be used.

3.7 Communication Wiring

- .1 The contractor shall adhere to the items listed in the "Wiring" article in Part 3 of the specification.
- .2 All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.
- .3 Do not install communication wiring in conduit and enclosures containing Class 1 wiring.
- .4 Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
- .5 When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to the manufacturer's instructions.
- .6 All runs of communication wiring shall be un-spliced length when that length is commercially available.
- .7 All communication wiring shall be labeled to indicate origination and destination data.
- .8 Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.8 Installation of Sensors

- .1 Install sensors in accordance with the manufacturer's recommendations.
- .2 Mount sensors rigidly and adequately for the environment within which the sensor operates.
- .3 Room temperature sensors shall be installed 1500 mm above the floor.
- .4 All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
- .5 Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

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- .6 Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m of sensing element for each 1 m² (1 ft of sensing element for each 1 ft²) of coil area.
- .7 All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
- .8 Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.
- .9 Differential air static pressure.
 - .1 Supply Duct Static Pressure: Pipe the high pressure tap to the duct using a pitot tube. Make pressure tap connections in accordance with the manufacturers instructions.
 - .2 Return Duct Static Pressure: Pipe the low pressure tap to the duct using a pitot tube. Make pressure tap connections in accordance with the manufacturers instructions.
 - .3 Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
 - .4 The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
 - .5 All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a vibration free location accessible for service without use of ladders or special equipment.
 - .6 All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves (provided by mechanical contractor) installed before the tee.

3.9 Actuators

- .1 Mount and link control damper actuators according to manufacturer's instructions.
 - .1 To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
 - .2 Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - .3 Provide all mounting hardware and linkages for actuator installation.
- .2 Electric/Electronic
 - .1 Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.

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- .2 Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.10 Warning Labels

- .1 Permanent warning labels shall be affixed to all equipment that can be automatically started by the DDC 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.

- .2 Permanent warning labels shall be affixed to all motor starters and all 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.

3.11 Identification of Hardware and Wiring

- .1 All wiring and cabling, including that within factory fabricated panels, shall be labelled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.
- .2 All pneumatic tubing shall be labeled at each end within 5 cm (2 in.) of termination with a descriptive identifier.
- .3 Permanently label or code each point of field terminal strips to show the instrument or item served.
- .4 Identify control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.
- .5 Identify all other control components with permanent labels. All plug-in components shall be labelled such that removal of the component does not remove the label.
- .6 Identify room sensors relating to terminal box or valves with nameplates.
- .7 Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.
- .8 Identifiers shall match record documents.

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3.12 Controllers

- .1 Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Control of an AHU or other mechanical equipment item will not be split between multiple controllers. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.
- .2 The building automation system will have a minimum of 10% spare I/O point capacity for each point type found at each location. If input points are not universal, 10% of each type is required. If outputs are not universal, 10% of each type is required. A minimum of one spare is required for each type of point used.
 - .1 Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional controller boards or point modules shall be required to implement use of these spare points.

3.13 Programming

- .1 Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% of available memory free for future use.
- .2 Point Naming: Point names shall be as shown on the equipment Points List provided with each Sequence of Operation. (Appendix A.) Where multiple points with the same name reside in the same device, the point name may be customized by appending its associated Program Object to the name. (ex: "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2, etc.)
- .3 Software Programming
 - .1 Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, shall be provided by the contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:
 - .1 Text-based:
 - .1 Must provide actions for all possible situations
 - .2 Must be modular and structured
 - .3 Must be commented
 - .2 Graphic-based:
 - .1 Must provide actions for all possible situations
 - .2 Must be documented

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.3 Parameter-based:

- .1 Must provide actions for all possible situations
- .2 Must be documented

.4 Operator Interface

- .1 Standard graphics - Provide graphics for all mechanical systems and floor plans of the building. This includes hot water system, boilers, spit systems and fans. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as set points.
- .2 The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third party software installation and integration required for successful operation of the operator interface.
- .3 The Contractor shall prepare system graphical displays and install on existing remote operator workstations located in RM Shop at Building H-36. Display inputs, outputs, and set points. Provide operator access from a point on the DWAN to allow the operator to command all outputs to manual value or return point to automatic control. Indicate alarm condition on graphical displays. Create separate displays that include schematic representations for each system. Create an overall graphic screen with hot "buttons" to detailed display screens. Create a separate graphic for each new system and a floor plan indication equipment room locations and remote sensor and actuator locations.
- .4 Real-time data shall be available upon cursor placement by operator when viewing programs.

3.14 Control System Checkout and Testing

- .1 Start-up Testing: All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Owner's representative is notified of the system demonstration.
 - .1 The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
 - .2 Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 - .3 Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
 - .4 Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.

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- .5 Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
- .6 Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all PID loops and any other control routines that require tuning.
- .7 Alarms and Interlocks:
 - .1 Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - .2 Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - .3 Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.
- .8 Setup and tune all control status loops. Make as many trips to the jobsite as necessary to complete the calibration programming.

3.15 Control System Demonstration and Acceptance**.1 Demonstration**

- .1 Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
- .2 The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The Owner will be present to observe and review these tests. The Owner shall be notified at least 10 days in advance of the start of the testing procedures.
- .3 The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
- .4 The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of 10% of the system randomly selected. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
- .5 As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.

Building Automation System

- .6 Demonstrate compliance with Part 1, "System Performance."
 - .7 Demonstrate compliance with sequences of operation through all modes of operation.
 - .8 Demonstrate complete operation of operator interface.
 - .9 Additionally, the following items shall be demonstrated:
 - .1 DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over damped control shall require further tuning by the Contractor.
 - .2 Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of setpoints and other affected equipment parameters.
 - .3 Interface to the building fire alarm system.
 - .4 Trend logs for each system that indicate set points, operating points, valve positions, and other data as specified in the Points List provided with each Sequence of Operation. (Appendix A.) These logs shall cover three 48-hour periods and have a sample frequency of not less than 10 minutes or as specified on the Points List. The logs shall be accessible through the system's user interface and retrievable for use in spreadsheets etc. as specified in Part 2 of this specification.
 - .10 Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.
- .2 Acceptance
- .1 All tests described in this specification shall have been performed to the satisfaction of the Owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the Owner. Such tests shall then be performed as part of the warranty.
 - .2 The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

Building Automation System

3.16 Cleaning

- .1 The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- .2 At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- .3 At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.17 Training

- .1 Provide training for a designated staff of Owner's representatives. Training shall be provided via self-paced training (Web-based, or Computer-Based Training), classroom training, or a combination of training methods. The training period shall be 8 hours.
- .2 The instructor(s) shall be factory-trained instructors experienced in presenting this material.
- .3 Classroom training shall be done using a network of working controllers representative of the installed hardware.

END OF SECTION

B.A.S. POINT SCHEDULE

SYSTEM	SS	TOD	OSS	DC	S	EWT	LWT	SAT	RAT	CO2	OAT	RH	CPA	A	ST	G	REMARKS
EXHAUST FANS	X	X			X									X		X	
PUMPS (4)	X			X	X			X						X		X	ALTERNATE LEAD PUMP WEEKLY
HEAT PUMP LOOP PUMPS (2)	X			X	X									X		X	DITTO
INDIVIDUAL HEAT PUMP UNITS	X	X	X		X								X	X	X	X	SEE SCHEMATIC - SYSTEM PRESSURE
HEAT PUMP HYDRONIC SYSTEM	X				X	X								X		X	
EXTERIOR LIGHTING	X	X			X									X		X	
ENERGY RECOVERY UNIT / ERV	X	X	X		X			X	X	X		X		X	X	X	
IT ROOM A/C					X			X	X					X	X	X	
RECIRC PUMP		X			X												
SOLENOID VALVE					X									X			VIA FLOW SWITCH
STORM WATER CISTERN					X									X			
WEEPER SUMP PIT					X									X			THRU CONTACT IN PUMP CONTROL PANEL
ECOLOGY UNIT	X				X									X		X	
AIR CURTAIN					X									X		X	
MAKE-UP AIR UNIT	X	X			X			X						X		X	

FUNCTIONS

- SS - STOP/START
- EWT - WATER TEMP. IN
- LWT - WATER TEMP. OUT
- SAT - SUPPLY AIR TEMP.
- IAT - INDOOR AIR TEMP.
- CO2 - CARBON DIOXIDE SENSOR
- RAT - RETURN AIR TEMP.
- H - HUMIDITY - RH
- ST - SPACE TEMP.
- G - GRAPHIC
- CPA - CONTROL PT. ADJUST
- A - ALARM
- TOD - TIME OF DAY
- OSS - OPTIMAL START/STOP
- S - STATUS
- DC - DUTY CYCLING
- DLC - DEMAND LOAD
- OAT - OUTDOOR AIR TEMP.

Sequence of Operation

PART 1 - GENERAL

1.1 General

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to General Mechanical Requirements: Section 21 05 00 as applicable.
- .3 Comply with ASHRAE 36.

1.2 Related Sections

- .1 Building Management System 23 09 33
- .2 Electrical Wiring: Division 26
- .3 Hydronic Specialties 23 21 14
- .4 Ecology Unit 237700
- .5 Work Provided under Division 26.
 - .1 Power at 120/1/60 will be provided for each control valve by control systems.
 - .2 Electrical interlock wiring of equipment specified under other Sections of Division 23 is responsibility of trade section installing that equipment, unless indicated otherwise.
- .6 Products Furnished but not Installed Under this Section
 - .1 Automatic control valves.
 - .2 Automatic control dampers.

PART 2 - PRODUCTS

N/A

PART 3 - EXECUTION

3.1 Sequence Of Operations

- .1 Exterior Lighting Control
 - .1 The exterior lighting control will be fully integrated with the BAS. The exterior lighting system has been zoned and is provided with contactors for control (contactors by this Division).
 - .2 Morality lighting (including building flood lighting) and Parking Lot Lighting shall have separate schedules).

Sequence of Operation

- .3 The above zones shall be on time of day schedules. Provide a schedule for each zone. Lighting shall be off from 0:00 hours to 17:00 hours, regardless of photosensor signal.
 - .4 Morality Lighting shall be enabled, subject to photosensor status, every evening from 17:00 hours until 09:00 hours the following day. (Operator adjustable)
 - .5 Parking Lot Lighting shall be enabled, subject to photosensor status every week night from 17:00 hours until 24:00 hours. (Operator adjustable)
 - .6 An exterior photometric sensor shall be monitored as a digital input point.
 - .7 The BAS shall report an alarm if the photosensor senses light between 23:00 hours and 04:00 hours, or darkness between the 10:00 hours and 15:00 hours. This shall be an indication that either the photosensor is not working, or the BAS system clock is incorrectly set.
 - .8 Install "Hand-Off-Auto" switches so that exterior lighting can be conveniently tested and re-lamped during daylight hours by staff not conversant with BAS operation.
 - .9 The BAS shall monitor the status of the fire alarm system. If the fire alarm is active, subject to photo-sensor status, the BAS shall turn on all exterior lighting under its control, and leave it on four hours after the alarm is cleared.
- .2 Energy Recovery Ventilator
- .1 Energy Recovery Ventilator units is supplied complete with integral damper, factor prewired. Unit will include necessary dry contacts and control functionally to meet the following requirements for supervisory control from the BAS.
 - .2 Energy recovery system shall be enabled/disabled based on time of day program, optimal start/stop and adjustable high and low limit setpoints through B.A.S. When unit is started, integral Energy recovery Ventilator controls shall operate.
 - .3 Unit shall be monitored for supply & return air temperatures and return air humidity from B.A.S. station. Unit shall also be monitored for leaving supply air temperature after heat recovery wheel and exhaust air temperature after heat recovery wheel.
 - .4 High or low supply and return air temperature conditions shall be alarmed at adjustable setpoint condition at B.A.S. station (i.e. 5oC before system shutdown).
 - .5 A low limit after heat exchanger set 7oC wired will stop Unit ONLY on low temperature condition.
 - .6 Provide indication at B.A.S. to monitor OA flow rates for ERV-01, exhaust air, supply air, cooling coil temperatures, supply air humidity and Unit status and dirty filters.
 - .7 Provide relays and wiring to complete control for interconnection to Energy Recovery Unit integral control.
 - .8 Duct temperature sensor shall modulate SCR control on electric duct coil to maintain discharge air temperature of 55°F.

Sequence of Operation

.3 Pump Control

- .1 The DDC system shall control and monitor the status of all HVAC and Domestic Hot Water pumps. Status of pumps shall be determined by a current transformer in conjunction with an AI point. Actual current draw in real time, expressed in amperes shall be available at the BAS. Connection to an auxiliary starter contact is not an acceptable alternative. Pump status shall be presented on the graphical display as an animation.

.4 Domestic Hot Water

- .1 The Building Automation System shall control the domestic hot water recirc pump on Time of Day. The BAS shall monitor the status of the DHW recirc pump by means of current transformers, and monitor the supply temperature.

.5 Heat Pumps

- .1 Each heat pump shall be controlled through a standalone intelligent DDC controller provided by the BAS Supplier and mounted on the heat pump cabinet, and a wall mounted intelligent electronic thermostat with programmable setpoint and mode override button, and no other features that will permit building occupants to interfere with the operation of the heat pump. Each stat to have jack in underside into which a palmtop computer can be plugged to access the entire system in text mode. See 23 81 40 "Heat Pumps Units" for full detail of control requirements. The thermostat shall have a limited temperature adjustment of 2 degrees up and down.
- .2 The BAS controller shall operate through the heat pump manufacturer's terminal strip to control fan, compressor and reversing valve to maintain space temperature. The fan shall run continuously when in "Occupied" mode, and intermittently when in "Unoccupied" mode. Provide control transformers and power controller independently from heat pumps.
- .3 The BAS controller will report any unit failure alarms generated by the heat pump's integral control system.
- .4 Temperature setpoints will be limited to a reasonable range. The "reasonable range" of temperatures can be set at the Operator Work Station by a building operator with adequate password authorization.
- .5 Upon receipt of an alarm from the heat pump, the DDC system shall generate a system alarm (and disable the heat pump, if this safety feature is not already built into the heat pump circuitry.)
- .6 The BAS controller shall continuously monitor the supply air temperature.
- .7 If the heat pump has been heating mode for at least 2 minutes, the BAS shall generate an alarm if the SAT is cooler than 30oC.
- .8 If the heat pump has been cooling mode for at least 2 minutes, the BAS shall generate an alarm if the SAT is warmer than 18oC.
- .9 The BAS Room Stat for the heat pump shall annunciate alarms generated by the local heat pump by flashing an LED continuously. Thermostat shall have the ability to set the temperature up or down by 2oC. Thermostat shall be able to override the unoccupied mode.

Sequence of Operation

- .10 The BAS shall calculate, on the basis of information updated at least once a minute, and present on a "Global Information" display:
- .1 Total number of heat pumps in occupied mode
 - .2 Total number of heat pumps in override mode
 - .3 Total number of heat pumps cooling
 - .4 Total number of heat pumps heating
 - .5 Total number of heat pumps in "alarm"
 - .6 Average space temperature
 - .7 Lowest space temperature
 - .8 Average heating offset
 - .9 Greatest heating offset
 - .10 Average cooling offset
 - .11 Greatest cooling offset
- .11 Upon resumption of power after a power outage, restore operation of the heat pumps in sequence to minimize the heavy current draw that would otherwise take place. (See also the sequence for Resumption of Power.) If heat pumps have "Random Start" built into their integral controls, the BAS need not duplicate that feature.
- .12 If the Heat Pump has a "Reset" terminal, it shall be possible to reset the integral heat pump alarms manually from the Operator Work Station.
- .6 Pumps Control
- Heat Pump Loop Pumps shall operate in a lead/lag sequence with monthly rotation on the first day of each month. One (1) pump shall be running at all times.
- When flow is required in the heat pump loop, the BAS will activate the magnetic starter for the lead pump. Should pump motor not start-up and develop normal run amperage as detected by current transformer, or if flow is not proven by means of the flow switch within 20 seconds, the BAS shall disable the lead pump and activate the standby pump, and register an alarm. Should the flow not be proven within twenty seconds, the BAS shall register a "Critical Alarm".
- (See Sequence for "Alarm Handling".)
- On loss of flow, start standby pump, deactivate all stages of control, report an alarm.
- When flow is proven or restored, or in the event of restoration of power after a power interruption, the equipment shall be staged on to prevent a large current inrush. (See Sequence for "Resumption of Power")
- Pressure switch in L.T. supply main shall control the VFD to maintain required flow.

Sequence of Operation

.7 Heat Pump Loop Alarms

The BAS shall monitor the loop temperature at the two main headers. In the event that flow is not proven within 20 seconds of starting up the lag pump, the BAS shall report a "Critical Alarm", which includes activating the alarm strobe light in the administration area.

On a loop temperature fall to 1.7 degrees C (35°F), the BAS shall report a Critical Alarm.

On a loop temperature rise to 40.6 degrees C (105°F), the BAS shall report a Critical Alarm.

The BAS shall generate a graph for the return loop average hourly temperature on a daily basis and archives it for a five year period.

.8 Exhaust Fan Control (Typical)

.1 BAS to control any exhaust fan greater than 75 watts (1/10 HP) by Time of Day program as long as following conditions are met:

- Not on local timer
- Not on light switch
- Not interlocked with other systems
- Not specified as part of separate controls.

.2 BAS shall control by interconnection to an H/O/A switch for each applicable fan.

.3 Provide relays where necessary to achieve stated sequence.

.4 Room thermostat shall start exhaust fan and open motorized damper on increase of room temperature above setpoint.

.9 IT Room A/C Units Monitoring

.1 The BAS shall control the A/C units to maintain room temperature.

.2 BAS shall monitor heat pump and room temperature for alarm condition (cool fail, supply air temperature dry filter).

.10 Ecology Unit

.1 The BAS shall start / stop the unit, record status and report dirty filter alarm

.11 Air Curtain

.1 The BAS shall monitor the status of the air curtain and record space temperature.

.12 Make-Up Air Units

.1 The make-up air units shall be controlled from its own integral DDC controller.

.2 The BAS shall start/stop, reset parameters, monitor, status and record alarms using BACnet interface card provided by unit manufacturer.

.3 All valves or damper actuators provided by equipment manufacturers shall be suitable Belimo Multifunction Technology, configured to accept a 2 – 10 VDC control signal, but field configurable to other standard control signals, including 0 – 10 VDC and 4 – 20 mAmps.

Sequence of Operation

- .4 The BAS shall monitor SAT reset adjustment, supply air temperature, fan(s) status and any other points as noted in points list.
- .5 The BAS shall register alarms if:
 - .1 SAT is out of range
 - .2 Fan status does not match commanded state
 - .3 Unit not heating when commanded, as indicated by SAT
 - .4 Flame status as indicated by dry contacts
 - .5 Flame failure or cooling alarm as indicated by dry contacts
- .13 Plumbing
 - .1 Totalize flow via pulse output reading from building water meter, make up water to rainwater cistern system and water consumption through rainwater supply meter, water supply to irrigation system, water make-up to irrigation system and domestic hot water recirc and domestic hot water and flow thru domestic hot water recirc pump.
 - .2 Record each solenoid valve open and close position, pump off and auto position.
 - .3 Generate high and low levels alarm with silencing switch in rainwater cistern.
 - .4 Building Automation System shall start and stop domestic water recirculation pump to suit time of day.
- .14 Metering
 - .1 Heating
 - .2 Cooling
 - .3 Domestic Water Heating
 - .4 Interior Lighting
 - .5 Plug load
- .15 Resumption of Power

BAS controllers and front end will restart on resumption of power without human intervention.

In the event of a power outage, upon restoration of power, the BAS shall stage on controlled equipment to prevent power surges

Equipment and systems must be restored in a logical order. For example, in the case of a heat pump system, the pumps should be restored first after generator starts (0-5 minutes time delay adjustable), followed by the boiler or fluid cooler, and finally the heat pumps.

The time between stages shall be sufficient to permit the first piece of equipment to startup, come up to speed, and settle down to drawing normal "run" amperage before starting up the next piece of equipment.

Sequence of Operation

Specify in the shop drawing submittals the order in which controlled equipment shall be restored to normal operation after resumption of power.

.16 Alarm Handling

Alarm handling shall be a function of the DDC controllers, rather than the operator interface software, and the following functionality will be available in text mode without sound, even if the Operator Interface Software is running.

Alarms will be designated "Critical" or "Non Critical".

"Critical" alarms shall be registered for conditions that are serious enough to compromise the ability of the building systems to support normal business activities. Alarms should not be designated "Critical" unless they would justify having the building operator attend the site, or at least dial in to the site after hours.

"Non Critical" alarms shall be registered for conditions that lack that urgency.

"Critical" alarms are designated on the points list as "CR", while "Non Critical" alarms are shown as digits.

In the event of a "Critical" alarm, the BAS shall send an email notification via SMTP communication protocol.

.17 Assignment of Access Levels

- .1 Divide operator access to system into 3 basic levels of operation, programming and configuration of system. Each level requires unique access code and operator's initials to sign on.

Level 1 permits review of status and statistical data in panel being accessed. This includes status and value of points, totalized run time and trend data. Level 1 also allows operator to manually start and stop points and acknowledge alarms.

Level 2 provides operator with ability to perform level 1 functions, and display or modify application program data. Normally issued to senior board staff only, who have responsibility for energy costs.

Level 3 provides access to programming and safety logic, including limits on adjustment ranges, and will require high level access. Normally issued only to customer or contractor technicians certified by the manufacturer.

- .2 Interface shall permit setpoint adjustment through graphics display using pulldown menus, mouse in conjunction with keyboard. Setpoint adjustments shall be password protected as follows:

Adjustment within limited range of nominal setpoint, low level password adjustment outside of limited range above, medium level password alarm setpoints, high level password.

Review of logs/status/system graphics shall be unprotected or low level password protected.

Programming, graphics display modifications shall be accessible only through medium/high level passwords as directed at system commissioning.

Sequence of Operation

.18 Naming Convention

- .1 CoB has standardized on Project Haystack naming convention. All newly created points to follow this convention regardless of new building or retrofit. Haystack naming convention to apply to all representatives of the points, whether it is the graphics, BACnet name or any other.
- .2 Each point shall be preceded by a 3 letter abbreviation of the building name and an underscore.
- .3 BAS Contractor shall provide Owner with functionality to export all point list.

END OF SECTION

Energy Management Guidelines

No. 3



Building Automation Systems Guidelines and Specifications (Formally No. 2)

Version 2.0
February, 2013

Energy Management Guidelines

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Energy Management



BAS Guidelines and Specifications

Disclaimer:

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Document History

Version	Date	Status or Changes	Author	Approvals
1.0	January 2010	Approved	Kashif Jahangir	Dale Pyne
1.8	March 2012	Updated	Kashif Jahangir	Dale Pyne
1.8.1	November 2012	Updated	Kashif Jahangir	Dale Pyne
2.0	February 2013	Updated	Carrie Webster	Dale Pyne

Note: The term Owner used throughout this document refers to the Energy Management team (City of Brampton).



1 SCOPE OF WORK

Design and construct Building Automation System (BAS) for building services with open protocol communications (BACnet).

New and existing installations use BACnet for all aspects of communication, including workstation, field panel, custom application controller and unitary controller communications and are commonly referred to as native BACnet systems.

2 GENERAL

2.1 Description

This section defines the Basic Materials and Methods provided by the Controls Contractor and used in the installation of BACnet Control products to provide the functions necessary for control of the mechanical systems on this project. Please be advised that the requirements of this specification will be strictly enforced. Systems that do not meet the requirements of the specification as outlined below will not be accepted.

- a. BACnet Advance Operator Workstation (B-AWS). Only one server based workstation are acceptable. This server application shall comply the city of Brampton's IT policies and accept existing operating system and other IT security policy. The server based workstation shall conform to BACnet Advanced Operator Workstation (B-AWS) device profile and shall be listed as a certified B-AWS in the BACnet Testing Laboratories (BTL) product listing.
- b. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135 (latest), and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
- c. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135 (latest).
- d. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135 (latest), and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
- e. Smart Actuators (SAs). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135 (latest), and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.



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- f. Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135 (latest), and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.
- g. Provide a Facility Management and Control System incorporating BACnet, Direct Digital Control (DDC), equipment monitoring, and control consisting of microprocessor based plant control processors interfacing directly with sensors, actuators, and environmental delivery systems (ie. HVAC units); electric controls and mechanical devices for all items indicated on drawings described herein including dampers, valves, panels, sensing devices; a primary communications network to allow data exchange between microprocessor based devices.
- h. The system will consist of a flat, open architecture that utilizes the latest ANSI/ASHRAE 135 BACnet protocol as the common communication protocol between all controlled and controlling devices. Where necessary or desired, BACnet packets may be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth. Hierarchical systems consisting of master or global controllers that poll and/or control less intelligent unitary controllers on a secondary bus will not be considered.
- i. The entire system network shall be a LAN. All nodes shall communicate with each other utilizing the latest ANSI/ASHRAE 135. There will be no consideration given to any network which does not use BACnet as the primary communications network. Controllers shall be capable of sharing standard network variable data with other LAN-based/BACnet devices.
- j. Controllers shall implement the full ANSI/ASHRAE 135 BACnet protocol (latest). Controllers must meet all of the requirements of this standard and must adhere to all of the protocol definition set forth by ANSI. All controllers shall be able to co-exist and interoperate on the BACnet network without interfering or limiting other controller's functionality. Controllers shall be able to be installed by any standard BACnet Network Services based network management tool.
- k. The system installed shall seamlessly connect devices other than HVAC throughout the building regardless of subsystem type (i.e. HVAC, lighting, and security devices should easily coexist on the same network channel without the need for gateways). Use of ANSI/CEA-852 layer 3/BACnet transparent routers is the only acceptable method spanning multiple channels and is the recommended method for system scalability. These components shall share common software for network communications, configuration, time scheduling, alarm handling, history logging, and custom programming. Any routers required by the system shall be supplied and commissioned as part of this specification.
- l. Gateways shall not be used unless specifically authorized in writing. Use of a gateway requires submittal of the documentation as required by the owner (Energy Management, City of Brampton) or owner's representative. It is the intent of this



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specification that gateways be limited to integrating legacy systems where applicable. Acceptance of gateways is at the sole discretion of the owner.

- m. System Monitoring shall be provided through the installation of Graphical User Interface (GUI) software applications (B-AWS) that support Native BACnet database. It must be BTL listed product. The GUI shall provide complete access to any point in the system at any time. A complete and fully commissioned BACnet's network database must be delivered for use with the GUI as a specific deliverable as defined on the project schedule. This database must include ALL node definitions, all channel and subnet definitions, all router and repeater definitions, and all bindings etc.
- n. The control system shall be designed such that mechanical equipment will be able to operate under stand-alone control. Functional methodology such as scheduling, trending, and alarming shall be outlined fully in your submittal documentation. Methodology must follow pertinent and applicable BACnet guidelines. Controllers that require a master computer or controller to perform basic functions are not acceptable. In the event of a network communication failure, or the loss of any other controller on the LAN network, the control system shall continue to independently operate under control of the resident program stored in nonvolatile memory as detailed herein.
- o. The documentation contained in this section and other contract documents pertaining to HVAC Controls is schematic in nature. The contractor shall provide all required hardware and software necessary to implement the functions shown or as implied in the contract documents.
- p. System configuration and monitoring will be performed using a standard PC-type computer. Under no circumstances shall the PC be used as a control device for the network. It can be used for storage of data, network management, and as a GUI. If the PC is taken off line, the control system shall continue to operate fully.
- q. All BACnet devices (controllers, sensors, actuators, etc) shall be integrated into one common network infrastructure utilizing a common network management tool and creating a single BACnet network database.
- r. All system controllers shall utilize a peer-to-peer communications scheme to communicate with each other and with the PC-type (browser based) monitoring computer(s). All controllers shall utilize BACnet's network as defined by BACnet. Controllers shall implement BACnet device profiles as appropriate. All devices shall be provided with an LAN/twisted wire plug-in configuration utility.
- s. Controllers shall contain non-volatile memory for storage of control programs, configuration, and set-points. All such data shall be retained in the event of a power failure. At least one controller shall have an on-board (battery or "super cap" backed) real-time clock to ensure correct time-of-day operation following a power failure. Controllers that are not backed-up in the event of a power failure and that



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require time based operation (VAV's, heat pumps, etc.) shall be peers on the network and be able to obtain time synchronization from a power fail protected controller and/or controllers upon network power restore.

- t. Historical data logging, alarm monitoring and management, and scheduling shall be accessible and managed via the GUI. The system may utilize specific controllers on the LAN to perform these functions or it may be performed by a host computer, or a combination of both.
- u. System shall utilize BACnet defined standard network and command messaging for all system data.
- v. In general, only BACnet certified devices will be accepted on this control network. Each device must be BACnet certified version or higher. In those instances in which BACnet devices are not available, provide BACnet devices with application source code, device resource files, and external interface definitions 1 week prior to bid date. Any controller that does not meet this spec must be stated and submitted with specific reason why it is not BACnet certified. BACnet compatible, BACnet compliant, and BACnet "ish" controllers are not acceptable. Exceptions may be granted for programmable controllers utilizing a custom programming software tools. These programmable controllers must meet all BACnet requirements for interoperability and shall utilize standard variable and configuration properties as defined by BACnet. Any custom software required for controller programming shall be included as a leave-behind tool with enough license capability built into the bid to support the installation.
- w. If a dedicated configuration tool is provided, it is preferable that it be launched from within the applicable Network Management Software. If not, any software required for controller configuration shall be included as a leave-behind tool with enough license capability to support the installation.
- x. The network infrastructure shall conform to the BACnet published guidelines for network wiring and system architecture. Wire type, distance, termination, and use of routers shall strictly conform to the BACnet wiring standards. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.
- y. Upon job completion, provide all drawings, product information, complete and functional databases, resource files, configuration files, etc on standard recordable media (CD, DVD).

2.2 Summary of Work

- a. New and existing installations use BACnet for all aspects of communication, including workstation, field panel, custom application controller and unitary



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controller communications and are commonly referred to as **native BACnet systems**.

- b. A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
- c. Each PC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing and minimum network speed of 10/100 mbps.
- d. BACnet routing shall be performed by PCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
- e. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or MS/TP (minimum speed of 78.8 kbps) Data Link/Physical layer protocol.
- f. Each ASC and SA shall reside on a BACnet network using the MS/TP (minimum speed of 78.8 kbps) Data Link/Physical layer protocol.
- g. 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 (minimum speed of 78.8 kbps) Data Link/Physical layer protocol.
- h. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
- i. Provide BACnet based products that communicate on multiple channels to meet the functional specifications as indicated on the Drawings and the dedicated product functional specifications and profiles specified in other sections.
- j. Provide BACnet/IP routers (PADS) and repeaters as required to combine different communication channels onto a central field bus or as required to segment groups of Intelligent Devices and/or Control Units.
- k. BACnet address should not be duplicated with any of the existing equipment city wide. Correct any issues with conflicting BACnet addresses on the City Network and verify with EMG for any available BACnet addresses. If the equipment is open to the network name the unit (site location/equipment name).
- l. Provide Intelligent Control Devices, Programmable Controllers, and Application Specific Controllers as herein specified, as needed to perform functions indicated in the input/output summaries and sequences of operation, and/or indicated on the mechanical and electrical drawings.



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- m. Implement start, stop, night setback, request based logic, and demand level adjustment of setpoints
- n. The BAS will be linking to the **IESO (Independent Electricity System Operator)** website for automatic demand reduction when prices are high. Provide a focused set of reports that includes essential information required for effective management of energy resources within the facility. Energy reports shall be configurable from predefined, pre-configured templates. Required information includes, but shall not be limited to:
 - Site energy overview
 - Equipment runtime
 - Load profile
 - Electrical energy
 - Simple energy cost
 - Energy production
 - Consumption

Reports shall be selectable by **date, time, area** and **device**. Each report shall include a color visual summary of essential energy information.

The System shall provide a Demand Limiting and Load Rolling program for the purpose of limiting peak energy usage and reducing overall energy consumption. The System shall support three levels of sensitivity in the Sliding Window demand calculations for fine tuning the system. The System shall have both a Shed Mode and a Monitor Only Mode of operation. The Demand Limiting program shall monitor the energy consumption rate and compare it to a user defined Tariff Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined strategy. The Load Rolling program shall sum the loads currently shed and compare it to a user defined Load Rolling Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined Load Priority.

Software shall be provided to configure and implement optimal start and stop programs based on existing indoor and outdoor environmental conditions as well as equipment operating history. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately to optimize energy use. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.

- o. Use a peak demand alarm: a simple announcement that the peak demand is being approached will allow operators to take action to avoid unnecessary demand peak.
- p. Provide wire, raceway systems, 24 VDC and/or 24 VAC power supplies and final connections to nodes provided by this contract. Must comply with electrical (Division) requirements.



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- q. The contractor shall provide all controls and sequence of operations as required by these specifications and by the drawings. Provide all required devices, sensors, hardware, software, wiring, controllers, etc. Provide all required devices, sensors, hardware, software, wiring, controllers, etc. including any required and not specifically addressed in this specification but required for system functionality. It shall be the responsibility of the contractor to provide a complete and functional system.
- r. The system shall allow for future integration of other systems (Card Access, Lighting, Intrusion Monitoring etc.) on the network proposed in this document, and also share a common infrastructure for network communications, time scheduling, alarm handling, history logging, monitoring and system control.
- s. Provide field calibration, testing and commissioning of equipment as specified herein.
- t. Incorporate Uninterruptible Power Supply surge transient protection in the installation of the system to protect electrical components in all BACnet controllers, remote controllers, and operator's workstations.
- u. Provide detailed start-up and system commissioning report (three copies) to the client. A third party commissioning agent (CA) will commission (CX) the entire new system. The CA will provide the detailed report to the consultant/engineer for review. The CX report shall be reviewed and stamped by the consultant/engineer to ensure that system is commissioned properly and quality is maintained as per client's guide lines and standards.
- v. An open protocol should be powerful and robust, capable of meeting all future communication needs, as well as the present needs throughout all system levels. Any communication protocol which doesn't meet these criteria should be eliminated from consideration.
- w. Wireless technology: The wireless field bus system shall employ ZigBee technology to create a wireless mesh network that provides wireless connectivity for BACnet devices at multiple system levels. Controls installer shall verify wireless network performance including online status verification and signal strength for all wireless connected devices and provide a printed report detailing network and wireless device status. All wireless devices shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems. Wireless devices shall be FCC compliant to CFR Part 15 subpart B Class A. Wireless devices shall operate on the 900MH / 2.4 GHZ ISM Band. (Not all BAS systems utilize wireless controls so please contact City of Brampton's Energy Management Group for further direction on wireless implementation).

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2.3 Acceptable BAS Vendors

The following is a listing of acceptable BAS vendors to provide native BACnet protocols. If any of the following vendor(s) is not capable to provide the products/services as per City's standards and guidelines it will be automatically removed from the list of approved BAS vendors.

1. Johnson Controls Co-operate/Branch Metasys EA
2. Delta Controls
3. TAC Automation (Automated Logic Corporation - WebCTRL)

2.4 Instruction of Owner Operating Personnel (Operator's Training)

All training shall be by the Controls Contractor and shall utilize specified manuals, as-built documentation, the on-line help utility and any other appropriate training materials.

Operator training shall include:

- Two (2) initial eight (8)-hour sessions for a group of four (4) people

The initial operator-training program shall be to establish a basic understanding of functions, commands, routines, etc. and shall assume attendees have a sound working knowledge of the Windows operating system and PC use. The training shall encompass as a minimum:

- a. Troubleshooting of input devices (i.e. bad sensors)
- b. Sequence of operation review
- c. Trends
- d. Logic
- e. Sign on - sign off
- f. Selection of all displays and reports
- g. Commanding of points (keyboard and mouse mode)
- h. Modifying label text
- i. Use of all dialogue boxes and menus
- j. System initialization
- k. BACnet Network Management Software (if applicable)

Provide a single software tool for setting up the system and configuring the operator/user interface. System and user interface functions shall include system command capability, system monitoring, system diagnostics and data archiving.

2.5 Remote Access

The owner shall provide an appropriate connection (static IP) to the Internet to enable remote system access. The owner agrees to pay monthly access charges for connection and ISP.



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2.6 Web Servers

2.6.1 Functionality

The Web Servers shall provide the interface between the LAN or WAN and the field control devices, and provide global control functions over the control devices connected to the Web Servers. It shall be capable of executing application control programs to provide:

- a. Hosting of the graphical HTML pages
- b. Calendar functions
- c. Scheduling (if no other means available)
- d. Data Logging (if no other means available)
- e. Alarm monitoring and routing (if no other means available)
- f. Time synchronization (if no other means available)
- g. Soap/XML interface
- h. Static or Dynamic IP addressing
- i. SNVT access via web pages and via XML interface
- j. SMTP Server for alarm email notification
- k. Messages and message management

2.6.2 Software License

The Software License for the Web Server(s) must be open and enable any Systems Integrator to engineer, change or modify the application once the project is complete. Restrictive engineering access to the Web server will not be acceptable. City of Brampton's IT will review the license to ensure that all applicable procurement laws and regulations have been followed (e.g., renewal period, copyright, limited warranty, liabilities and other terms & conditions)

2.6.3 Event Alarm Notification and Actions

- a. The Web Server shall provide alarm recognition, storage, routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
- b. The Web Server shall be able to route any alarm condition to any defined User location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.
- c. Alarm generation shall be selectable for annunciation type and acknowledgement requirements.
- d. Control equipment and network failures shall be treated as alarms and annunciated.
- e. Alarms shall be annunciated via email notification to specific, configurable email address.



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- f. Alarms shall be visually identified via the HTML graphics pages. Overrides and set point changes shall be configured via the HTML interface.
- g. Alarms shall be annunciated in any of the following manners as defined by the user:
 - Screen message text
 - Pagers via paging services that initiate a page on receipt of email message
 - Graphic with flashing alarm object(s)
- h. Alarms shall be logged for a period of no less than 1 week
- i. Alarm logs shall be able to be transferred from the web server to a host
- j. The following shall be recorded by the Web Server for each alarm (at a minimum):
 - Time and date
 - Location (building, floor, zone, office number, etc.)
 - Equipment (air handler number, access way, etc.)

2.6.4 Data Logging and Storage

The web server shall have the ability to collect data for any object and store this data for future use. Data logging shall be performed either by a dedicated logger on the control network, via a combined web server/data logger, or by a central host PC attached to the network. Whichever way data logging is to be performed it must:

- a. Store data logs for at least 4 week before being overwritten
- b. Automatically update the host storage PC that the logs are approaching their full level
- c. Data logs shall be able to be transferred from the web server to a host
- d. Be easily able to append a new log to a previously saved log

2.6.5 Security and User Administration

- a. Communications between the Web Server and Web Browser are to adopt proven 'Secure User Authentication' employing 128-bit industry standard MD5 digital signatures. All transactions to/from the Web Server are to adopt the MD5 security procedures as a minimum to ensure the data on the system is protected from unauthorized access.
- b. Individual web graphics pages shall have their own password protection. Groups of pages may have the same password for the same level of user. Provide at least 3 levels of user access.

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2.6.6 Main (Central) Server for all BAS

All BAS vendors are responsible to upgrade the existing BAS server with the latest version during the execution of this contract/project.

A dedicated server for all BAS operation is residing in City Hall. City of Brampton's IT group will provide access to the BAS vendor to the existing server to install, interface and configure the new/existing BAS. Computer supplied by vendor for BAS operations is not acceptable. A dedicated computer for BAS is not required unless otherwise needed. BAS Vendor is responsible to interface the new/existing BAS to the available server (VM). All trends, graphs and database will be residing in the existing server (VM). Please contact Energy Management group for details.

2.6.7 Web Browser Clients

- a. The system shall be capable of supporting a minimum of 10 simultaneous client connections using a standard Web browser such as Internet Explorer™, Firefox™, or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
- b. The Web browser shall provide a view of the system, in terms of graphics, schedules, calendars, logs, etc. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

3 BAS Hardware Identification

3.1 Automatic Control Valve Tags

- a. For valves, etc., use metal tags with a 2-inch minimum diameter, fabricated of brass, stainless steel or aluminum. Attach tags with chain of same materials. For lubrication instructions, use linen or heavy duty shipping tag.
- b. Tag valves with identifying number and system. Number valves by floor level, column location and system served.
- c. Prepare lists of all tagged valves showing location, floor level, and tag number use. Prepare separate lists for each system. Include copies in each maintenance manual.



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3.2 Wire Tags

All multi-conductor cables in all pull boxes and terminal strip cabinets shall be tagged.

3.3 Conduit Tags

Provide tagging or labeling of conduit so that it is always readily observable which conduit was installed or used in implementation of this work.

3.4 Miscellaneous Equipment Identification

- a. Screwed-on, engraved black lamicaid sheet with white lettering on all control panels and remote processing panels. Lettering sizes subject to approval.
- b. Inscription (subject to review and acceptance) indicating equipment, system numbers, functions and switches. For panel interior wiring, input/output modules, local control panel device identification.

4 User Interface/Operator Work Station (OWS) Hardware and Telecommunication Protocols

City of Brampton's IT department has four years life cycle standard program for all Hardware and software. This program is applicable to all new BAS construction. BAS Contractor is to follow the IT (CoB) specifications/guidelines for hardware, printer(s), software and telecommunications protocols. IT department (CoB) will provide PC, laptop, printer and other work station's hardware. Project Manager, Project Coordinator and IT's program Manager will validate the supply and installation of workstation(s) and peripheral devices.

5 Sequence of Operations

Refer to drawings for normal operating mode sequences of operations.

5.1 General

- a. Provide automatic control for system operation as described herein, although word "automatic" or "automatically", is not used.
- b. Provide control devices, control software and control wiring as required for automatic operation of each sequence specified.



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- c. Manual operation is limited only where specifically described; however, provide manual override for each automatic operation.
- d. Where manual start-up is called for, also provide scheduled automatic start-stop capabilities.
- e. Functions called for in sequence of operations are minimum requirements and not to limit additional capabilities the DDC system can be provided with.
- f. Provide the following functions which are not specifically mentioned in each sequence of operation for each item of equipment:
 - I. Start-Stop, manual, and scheduled
 - II. On-Off status of each piece of equipment
 - III. Run-time
 - IV. All set-points shall be adjustable
 - V. Sequenced starting of all motors

5.2 Temperature Sensors

- a. Temperature sensor assemblies shall be readily accessible and adaptable to each type of application in such manner as to allow for quick, easy replacement and servicing without special tools or skills.
- b. Strap-on mountings shall not be permitted.
- c. Outdoor installations shall be of weatherproof construction or in appropriate NEMA enclosures. These installations shall be protected from solar radiation and wind effects. Protective shield shall be stainless steel.
- d. Sensors shall be with enclosure where located in finished space.
- e. Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only and shall not be located in dead air spaces or positions obstructed by ducts, equipment, and so forth. Locations where installed shall be within the vibration and velocity limit of the sensing element. Ducts shall be securely sealed where elements or connections penetrate ducts to avoid measuring false conditions.
- f. All sensors measuring temperatures in pipes larger than 2 inches in diameter or in pressure vessels shall be supplied with wells properly fabricated for the service. Wells shall be non-corrosive to the medium being measured and shall have sufficient physical strength to withstand pressures and velocities to which they are subjected. Wells shall be installed in the piping at elbows where piping is smaller than the length of the well to affect proper flow across the entire area of the well.

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6 Schedule of Responsibilities

The following schedule identifies the responsible Division for the installation of the facility automation system and should be used as a general guide. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Architect.

	Item		Furnish by:	Install by:	Power by:	Control wiring by:
1	Equipment Motors		M	M	E	---
Magnetic Motor Starters:						
2	A)	Automatically controlled with or without HOA switches	E	E	E	TCC
3	B)	Manually controlled	E	E	E	---
4	C)	Manually controlled, and which are furnished as part of factory wired equipment	M	M	E	E
5	D)	Special duty type (part winding, multi-speed etc.)	M	See note 1	E	See note 1
6	E)	Adjustable frequency drives with manual bypass	TCC	TCC	E	See note 2
7	F)	Domestic booster pump motor controls	M	M	E	TCC
8	General equipment disconnect switches, thermal overload switches, manual operating switches		E	E	E	---
9	Sprinkler system water flow and tamper switches		M	M	E	---
10	Outside fire alarm horn and light (at Siamese connection)		M	M	E	---
11	Line voltage contactors		E	E	E	TCC
12	Control relay transformers (other than starters)		TCC	TCC	E	TCC
13	Main fuel oil tank alarms (high and low level) and remote indicating lights		M	M	TCC	TCC

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14	Day tank fuel oil alarms (high and low level) and remote indicating lights		E	E	E	TCC
15	Line voltage control items (e.g.: line voltage t-stats not connected to control panel systems)		M	E	E	E
16	Loose control and instruments furnished as part of the mech. Equip. or required for operation (e.g.: valves, float controls, relays, sensors etc)		M	M	M	M
17	Control and instrumentation panels		TCC	TCC	E	TCC
18	Automatic control valves, automatic dampers and damper operators/actuators, solenoid valves, insertion temperature and pressure sensors		TCC	M	E	TCC
19	Duct type fire and smoke detectors including relays for fan shut-down		TCC	TCC	E	TCC
20	Contactors for cooling tower basin heaters		M	M	E	M
21	Mechanical piping heat trace (inc. relays, contactors, t-stats etc.)		M	M	E	M
22	Emergency-Power-Off (EPO) shutdown push-button(s), (break-glass station) and controls		M	M	M	M
23	Control interlock wiring or software bindings between chillers, pumps and cooling towers, fans and air handling units and other miscellaneous mechanical equipment		TCC	TCC	E	TCC
24	Electric radiant heating panels, un-ducted electric unit heaters and cabinet heaters and electric baseboard radiation units		E	E	E	E
25	Airflow control device with transmitter		TCC	M	E	TCC
26	Air terminal devices (e.g. VAV boxes)		M	M	E	TCC
Intelligent devices and control units provided with mechanical equipment such as:						
27	A)	Valve and damper operators	M	M	E	TCC
28	B)	Heat pumps, AC units	M	M	E	TCC

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29	C)	Fan coil units	M	M	E	TCC
30	D)	Air terminal units	M	M	E	TCC
31	E)	Boilers, Chillers, etc.	M	M	E	TCC
Intelligent devices and control units provided with electrical systems such as:						
32	A)	Occupancy/motion sensors	E	E	E	TCC
33	B)	Lighting control panels	E	E	E	TCC
34	C)	Switches and dimmers	E	E	E	TCC
35	D)	Switch multiplexing control units	E	E	E	TCC
36	Door Entry Control units		TCC	TCC	E	TCC
37	Gateway for protocol conversion with non-BACnet/ LAN based systems		TCC	TCC	TCC	TCC
38	Routers, bridges and repeaters		TCC	TCC	TCC	TCC
Abbreviations:						
39	E	Electrical Contractor				
40	M	Mechanical Contractor				
41	Power	Power wiring connection, low and medium voltage				
42	TCC	Temperature Controls Contractor				

Notes to Schedule of Responsibilities:

- I. *Magnetic motor starters (special duty type) shall be set in place under electrical division except when part of factory wired equipment, in which case set in place under mechanical division.*
- II. *Where a remote motor disconnect is required in addition to the one provided integral to an Variable Frequency Drive (VFD), the Controls Contractor shall provide the necessary control interlock between the disconnects.*
- III. *The Controls Contractor shall inform the Mechanical Contractor and the Electrical Contractor of the additional capacity required of control power transformers.*
- IV. *The Mechanical Contractor shall refer to the electrical specifications and plans for all power and control wiring and shall advise the Architect of any discrepancies prior to bidding. The Controls Contractor shall be responsible for all control wiring as outlined, whether called for by the mechanical or electrical drawings and specifications.*



7 Abbreviations

AGC	Application Generic Controller	GUI	Graphical User Interface
ASC	Application Specific Controller	HVAC	Heating, Ventilating and Air Conditioning
BAS	Building Automation System	ITC	Intermediate Telecommunications Closet
BMS	Building Management System	I/O	Input/Output
B-BC	Building Controllers	LAN	Local Area Network
B-AAC	Advanced Application Controllers	NSS	Network Services Server
B-ASC	Application specific controllers	NSI	Network Services Interface
B-SS	Smart Sensors	NFPA	National Fire Protection Association
B-SA	Smart Actuators	OI	Operator interface
CA	Commissioning Agent	OS	Operating System
CAC	Custom Application Controller	OWS	Operating Work Station
CoB	City of Brampton	PE	Pneumatic-electric
COS	Change of State	PID	Proportional Integral Derivative
CPU	Central Processing Unit	PRV	Pressure Reducing Valve
CX	Commissioning	PSI(g)	Pounds per square inch (gauge)
DDC	Direct Digital Controller	RAM	Random Access Memory
DPR	Damper	SCADA	Supervisory Control and Data Acquisition System
DPU	Digital Point Unit	TCS	Temperature Control System
DRF	Device Resource File	TCC	Temperature Control Contractor
DWGS	Drawings	UL	Underwriters' Laboratory
EMCS	Energy Monitoring Control System	VAV	Variable Air Volume
EP	Electric-pneumatic	VCS	Voice Communication System
FAS	Facility Automation System	WC	Water Column
FPB	Fan Powered VAV Box	XIF	External Interface File
FPM	Feet per minute		
FACP	Fire Alarm Control Panel		
FCC	Fire Command Center		
FMS	Fire Management System		
GPM	Gallons per minute		



Appendix A:

Building Automation System Design Checklist

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Best Practices - Building Automation Systems Design Checklist (Office facilities)

Equipment Description	BAS Function/Strategy	Outside air temp	Water temperature	Space temperature	Burner control	Pump control	Supply air temperature	Mixed air temperature	Htg & cly coil valves	Damper control	Return air temperature	Fan control	Occupancy sensor	Humidity Control	Chiller output control	Slide valve position feedback	System suction pressure	System head pressure	Lighting control	Photo sensor	Snow Sensor
Hot water boilers	Reset water temperature Maximize on-time by 1st on 1st off Ensure complete modulating control or proper hi-low control	✓	✓		✓																
Heating water	Maintain one setpoint and stage using time interval rather than error from setpoint Stop circulating water through non-firing boilers	✓	✓		✓	✓															
Air systems	Reset water temperature with outside air temperature Reset water temperature from building space temperature Supply air temperature reset from outside air temperature Trim supply air temperature setpoint with feedback from spaces Mixed air control - calculate and control to minimum ventilation Integrated economiser (provide required supply air temperature) Scheduling - minimize scheduled time Scheduling - optimal start Scheduling - no outside air when systems operate in unoccupied hours Occupancy sensing - operate fan or open outside air dampers only when occupied Set humidity to minimum required Reset humidity at very low temperatures Space pre-cool (morning) Schedule recirculation pump for occupied periods only Reduce setpoint to minimum required temperature	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DHW	Profile tank water temperature - reduced temperatures will reduce recirculation heat loss If tank separate from heater, do not circulate water through non-firing heater	✓	✓																		
Cooling	Reset supply water temperature up if building systems are not variable flow Shut off chiller when no cooling required Shut off chilled water pumps when cooling not required Sequence operation of different size chillers to optimize operation Sequence operation of different size cooling towers to optimize operation Sequence lead-lag operation of cooling towers to operate at best efficiency Occupancy sensing to shut off constant volume or variable volume boxes plus lights	✓	✓	✓									✓		✓						
Zone control	Occupancy sensing to shut off constant volume or variable volume boxes plus lights		✓										✓						✓		
Lighting	Schedule Photo sensor control Use snow sensor				✓														✓	✓	✓
Snow melting	Schedule																		✓		
Outdoor lighting	Trim schedule using photo sensor																		✓	✓	✓
	Trim schedule using sunset-sunrise calculation																		✓	✓	✓

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Best Practices - Building Automation Systems Design Checklist (Arenas) Continued

Equipment Description	Outside air temp	Water temperature	Space temperature	Burner control	Pump control	Supply air temperature	Mixed air temperature	Htg & cly coil valves	Damper control	Return air temperature	Fan control	Occupancy sensor	Chiller output control	Slide valve position feedback	System suction pressure	System head pressure	Lighting control	Photo sensor	Ice temperature	Brine heat exchange control	CO2 sensor	
BAS Function/Strategy																	✓					
	Schedule with activities - minimize operating hours											✓										
	Schedule with activities - use occupancy sensors to optimize											✓										
	Schedule HID Hi/Low dimming with activities - minimize operating hours																					
	Schedule HID Hi/Low dimming with activities - use occupancy sensors to optimize											✓										
	Schedule recirculation pump for occupied periods only					✓																
	Reduce setpoint to minimum required temperature		✓		✓																	
	Profile tank water temperature-lower temperatures will lower recirculation heat loss		✓		✓																	
	If tank separate from heater, do not circulate water through non-firing heater		✓			✓																
	Maximize on-time by 1st on 1st off				✓																	
Gas-fired infra red heaters			✓	✓																		
Exhaust fans			✓	✓																		
	Schedule										✓											
Supply air systems	Occupancy override to schedule										✓											
	Scheduling - minimize scheduled time										✓											
	Occupancy override to schedule										✓											
	Scheduling - optimal start	✓									✓											
	Control outside air volume to occupancy requirement using CO2		✓								✓											
Integrated economizer	✓																					
Trim supply air temperature setpoint from space temperature			✓																			



Electrical Specifications for
Century Gardens Community Youth Hub
342 Vodden Street East
Brampton, ON
JSC Project No. 22-144

Issued for Addenda

Date: February 12, 2024

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275313	Clock Systems
275400	Assisted Listening System
282300	Security Systems

Electrical General Requirements

PART 1 - GENERAL**1.1 General Requirements**

- .1 The General Conditions of CCDC-2 Division 1, form part of this section, and must be read in conjunction with the requirements of this section, and all related sections.
- .2 The work of this section, and related work specified in other sections shall comply with all requirements of Division 1 – General Requirements.
- .3 Conform to the conditions stated in the Contract Form and Supplementary Conditions.
- .4 This section of the Specification is an integral part of the Contract Documents and shall be read accordingly. This Section applies to and is a part of all Sections of Divisions 26.

1.2 Intent

- .1 Mention herein or indication on Drawings of articles, materials, operations or methods requires: supply of each item mentioned or indicated, of quality, or subject to qualifications noted; installation according to conditions stated and; performance of each operation prescribed with furnishing of necessary labour, equipment, tools, instruments, services and incidentals for Electrical Work, Division 26.
- .2 Sections of these Electrical Specifications are not intended to delegate functions nor to delegate work and supply to any specific trade and the work shall include all labour, materials, equipment, tools and inspection required for a complete and working installation as described.
- .3 The Specifications are integral with the Drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one, but included in the other is properly specified.
- .4 Wherever differences occur in the Contract Documents, the maximum conditions will govern and be allowed for in the Base Bid Price. The item to be incorporated will be at the option of the Consultant.

1.3 Definitions

- .1 Where used, words "Section" and "Division" shall also include other SubContractors engaged on site to perform work to make building and site complete in all respects.
- .2 Where used, the word "products" shall mean the material, equipment, component, machinery, or fixtures forming the completed work.
- .3 Where used, word "connect" shall mean to supply and install all wiring and raceways and make all power connections to products.
- .4 Where used, word "supply" shall mean to include all labour, materials and services to furnish to site in location required or directed complete with accessory parts, but is not intended to include installation.

Electrical General Requirements

- .5 Where used, word "install" shall mean to include all labour, materials and services to secure in place products, including receiving, unloading, transporting, storage, uncrating, installing, connecting and performance of such testing and finish work as is compatible with degree of installation specified complete ready for use.
- .6 Where used, word "provide" shall mean to supply and install as each is described above.
- .7 Where used, word "commission" shall mean to startup and initial operation of products as required to demonstrate satisfactory operation of products and entire system including calibration of any instrumentation.
- .8 Where used, word "work" shall mean the total construction required by the Contract Documents and includes all labour, products and services.
- .9 Where used, wordings such as "approved, to approval, as directed, permitted, permission, accepted, acceptance, report to", shall mean "approved, directed, permitted, accepted, report to", by Consultant.

1.4 By-Laws and Regulations

- .1 Conform to latest Government, Provincial and Municipal By-laws, regulations, Codes and Standards and requirements of other authorities having jurisdiction in the area where work is to be performed. Minor changes required by an authority having jurisdiction shall be carried out without change to the Contract amount. Standards established by Drawings and Specifications shall not be reduced by applicable codes or regulations.
- .2 Conform to the following applicable standards and regulations as minimum, but not limited to:
 - Canadian Standards Association (CSA) Standards
 - Underwriter's Laboratories of Canada (ULC) Standards
 - Ontario Electrical Safety Code (OESC) and Bulletins
 - Electrical Safety Authority (ESA) Requirements
 - Canadian Underwriters Association (CUA) Standards
 - Ontario Building Code (OBC)
 - National Fire Protection Association (NFPA) Standards
 - National Electrical Manufacturers Association (NEMA) Standards
 - Electrical and Electronic Manufacturers Association of Canada (EEMAC) Standards

1.5 Permits and Fees

- .1 Apply for, obtain, and pay for permits, licences, certificates, connection charges and inspections required by authorities having jurisdiction. Include any premiums applicable due to requirements for after office hours inspections.

Electrical General Requirements

- .2 The first submission of plans and Specifications to ESA will be made by the Consultant. From then on, this Contractor shall be responsible for obtaining and complying with all the requirements of ESA.
- .3 Submit all required documentation to the Authorities for their approval and comments before starting any Work. Provide all additional Drawings, details or information as may be required. Comply with any changes requested by authorities as part of the Contract, but notify the consultant immediately of such changes.

1.6 Examination of Site and Conditions

- .1 Examine the site and local conditions. Examine carefully all Drawings and complete Specifications to ensure that work and equipment will satisfy conditions and performance requirements as shown. Examine the work of other contractors and report at once any defect or interference affecting the work, its completion or warranty. No allowance will be made later for any expense incurred through failure to make these examinations or to report any such discrepancies and omissions in writing prior to Tender closing.
- .2 Submission of a bid confirms that the Contract Documents and site conditions are completely understood and accepted without qualifications.

1.7 Contract Documents

- .1 The Contract Drawings of this Division are performance Drawings and indicate the scope and general arrangement of the Work. They are diagrammatic except where specific details are given. They shall be read in conjunction with Architectural, Structural, Mechanical and all other Division Drawings of the Contract.
- .2 Obtain accurate dimensions from the architectural and structural Drawings, or by site measurement. Locations and elevations of services are approximate and must be verified before construction is undertaken.
- .3 Make changes required to accommodate structural conditions, (beams, columns caps, etc.). Obtain Consultant's approval before proceeding.
- .4 Adjust the location of materials and/or equipment up to 3 meters in any direction as instructed without adjustment to Contract Price, provided that the instructions are given before installation and rough-in.
- .5 The Drawings do not show all conduit and/or wiring or all structural, mechanical and architectural details. Plan and install conduit runs respecting all applicable conditions including structural, mechanical and architectural details.

1.8 Shop Drawings

- .1 Prepare and submit Shop Drawings of all Products in accordance with Division 1-General requirements as specified herein and in each section of Division 26.

Electrical General Requirements

- .2 Submit eight (8) copies of Shop Drawings. Shop Drawings shall have a minimum 210 mm x 285 mm (8-1/2" x 11") clear space on the front sheet, suitable for stamping. The cover sheet shall include the project name, Division 26 name and Product description. Where multiple equipment is submitted under one binding, include an index of all equipment as the front sheet.
- .3 Assume full responsibility for submission of Shop Drawings. Allow minimum two (2) weeks for Consultant's review.
- .4 The Consultant will only review Shop Drawings bearing the Division 26 and Contractor's stamps of approval.
- .5 Submit Shop Drawings showing the following:
 - .1 Submit Shop Drawings showing the following:
 - .2 Project name.
 - .3 Project tag number.
 - .4 Manufacturer's name and model number.
 - .5 Supplier's name.
 - .6 Approval agencies.
 - .7 Shipping and working weight.
 - .8 Performance characteristics.
 - .9 Dimensions, including required clearances.
 - .10 Electrical characteristics.
 - .11 Bill of materials and finishes.
 - .12 Time required to fabricate and deliver.
 - .13 All variations from Tender Documents.
 - .14 Construction and field connection details.
 - .15 Installation requirements.
- .6 The Consultant's review shall not relieve this Division of responsibility to provide Products in accordance with the design intent and Contract Documents.
- .7 Manufacturer's printed data sheets for standard items are acceptable providing pertinent characteristics are identified and relate to specified items.
- .8 Each Shop Drawing shall be checked and stamped as being correct, by trade purchasing item, and by Contractor, before Drawing is submitted. If above requirements are not complied with, Shop Drawings will be rejected and returned forthwith.
- .9 Where applicable, provide wiring details, schematics, single line Drawings, and wiring diagrams showing interconnection with work of other Trades.

Electrical General Requirements

- .10 Verify and check dimensions to ensure proper installation of equipment in available space and without interference to work of other Trades. Ensure that electrical and all other coordination is complete prior to submission of Shop Drawings.
- .11 Provide data sheets and samples for all wiring devices and wall plates prior to installation. Device and plate colours/finishes to be confirmed prior to ordering.
- .12 Where requested, submit samples of Products for review and approval.
- .13 Do not have equipment delivered to site until a Shop Drawing for the item has been reviewed.

1.9 Interference and Detail Drawings

- .1 Prepare Interference Drawings in conjunction with all parties and trades concerned showing sleeves and openings and passage of piping and conduits through building structure. Drawings shall also show inserts, curbs, equipment bases, anchors, special hangers and weights on all load points.
- .2 Prepare fully dimensioned detail 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, sleeves, electrical connections, and elevations of pipes, ducts and conduits. Include location of access doors provided under this Division.
- .3 Ensure that clearances required by jurisdictional authorities are indicated on the Interference Drawings. The Owner will not consider any extra cost as a result of the Contractor's failure to prepare proper Interference Drawings.

1.10 Record Drawings

- .1 Conform to General Requirements. Maintain at least 2 sets of documents and clearly mark on same as job progresses, changes and deviations from work shown so that on completion Owner will have records of exact location of ducts and equipment and record of material and equipment changes.
- .2 Contractor shall obtain clean set of prints from Consultant at start of Contract Work and shall keep these prints up-to-date at jobsite, accurately recording all changes made on project and locating all services, equipment, etc. which may have been shown only diagrammatically on Contract Documents.
- .3 Contractor shall ensure that as-built information is accurately recorded and shall check same. As-Built Drawings shall be reviewed with Consultant at each jobsite meeting.
- .4 Prepare record drawings showing the following:
 - .1 Inverts of all services entering and leaving the building and at property lines.
 - .2 Dimensions of underground services in relation to property lines at key points of every run.
 - .3 Elevations of underground services in relation to ground floor level of the building.

Electrical General Requirements

- .4 Location of all services embedding in the structure, utilizing grid line references.
 - .5 Dimensioned locations of all services left for future work.
 - .6 All changes to the Work due to Change Orders and Site Instructions.
 - .7 All changes to the Work during construction.
 - .8 All changes to structural and architectural elements that affect the backgrounds of this record set.
 - .9 Location and designation of all electrically supervised valves, flow switches and pressure switches.
 - .10 Location and designation of all items requiring access or service in a hidden location.
 - .11 Location of all access doors provided under Division 26.
 - .12 All changes and revisions to Specifications, details and equipment schedules.
 - .13 All homerun conduits, junction boxes for complete electrical systems.
- .5 Upon completion of Contract Work, prior to Substantial Performance inspection and after final review with Consultants, Contractor shall issue to the Consultant for review the actual on site As-Built Drawings. Upon acceptance Contractor shall neatly transfer recorded information and make final As-Built submission to Consultant for review in the following form:
- .1 One (1) set of clean, legible prints.
 - .2 One (1) ACAD 2019 format drawings. Files shall retain all setting (layers, line types, scales colors, etc) as used in the drawing files (produced) by consultant.
- .6 After Record Drawings have been reviewed, revised if necessary until acceptable to the consultant. Deliver drawings in the form of CD (CAD + PDF) and three (3) sets of prints taken from that CD to Owner.

1.11 Operation and Maintenance Manual

- .1 Contractor will be responsible for collecting and organizing three (3) copies of all data, operating instructions, maintenance and trouble-shooting instructions, parts lists, parts diagrams, evidence of all tests and certifications, complete reviewed Shop Drawings, etc. and assembling them in neat manuals in hard cover. Identify cover "Operation and Maintenance Manual for NAME OF THE PROJECT". Manuals shall be separated with dividers in logical sections and volumes.
- .2 Contractor shall also collect from Sub-trades and Suppliers all Guarantees/Warranties specified. Check that starting date (date of Substantial Performance of entire Project) and extent of each guarantee/warranty are clearly indicated. Check also that all guarantees/warranties indicate Supplier's Name or SubContractor's Name as appropriate together with contact phone number. Assemble neatly in labeled section of each manual.

Electrical General Requirements

- .3 Prior to requesting Substantial Performing inspection, submit one (1) copy to Consultant for review. Make all corrections requested by Consultant and forward the corrected two (2) copies to the Owner.

1.12 Scheduling

- .1 Comply with the construction schedule. Conform to phasing of work if applicable. Conform to interim and final completion dates.
- .2 Co-ordinate electrical schedule with general construction schedule.
- .3 Submit a bar chart schedule showing the start and completion dates for each activity based on a critical path analysis of the work.
- .4 Include in schedule for electrical work done by others, e.g. Power Supply Authority connection.

1.13 Alternates and Substitutions

- .1 Refer to Section 01 60 00 – Product Requirements and comply accordingly.

1.14 Valuation of Changes

- .1 For each change submit a complete itemized breakdown of labour and material.
- .2 Only the net difference between an extra and a credit will be subject to overhead and profit mark-up.

1.15 Workmanship

- .1 Workmanship and method of installation shall conform to best standards and practice and be performed to approval. Work shall be done by tradesmen skilled in work to be performed. Where required by local or other By-Laws and Regulations, tradesmen shall be licensed in their trade. Install all work and equipment to manufacturer's printed directions.

1.16 Installation Requirements

- .1 Coordinate the Work with all Divisions. Inform other Divisions of the locations of openings, chases, sleeves, supports, services, connections, etc., to be incorporated into the Work.
- .2 Check the locations of all expansion/building joints and ensure that all electrical installations are at or crossing these locations are as detailed and as required to compensate for the possible movement at the joint.
- .3 Confirm the exact location of outlets, fixtures and connections. Check architectural details and elevations for more requirements. Confirm location of connection points for equipment supplied under other Divisions or by the Owner.
- .4 Install neatly all equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.

Electrical General Requirements

- .5 Install metering and/or sensing devices to provide accurate and reliable sampling of quantities being measured. Install instruments to permit easy observation.
- .6 Provide suitable shielding and physical protection for devices.
- .7 Install all Products and services in accordance with the manufacturer's requirements and/or recommendations.
- .8 Provide all supports, hangers and fasteners. Secure all Products and services so as not to impose undue stresses on the structure and systems.
- .9 Ensure that the load onto structures does not exceed the maximum loading per square meter (foot) as shown on Structural Drawings or as directed by the Consultant.
- .10 Do not use explosive activated tools.

1.17 Field Review

- .1 The Owner and Consultant shall have access to the site at all times for review of the work during construction.
- .2 Arrange for review of Products during manufacturing.
- .3 Provide all gauges, instruments and other necessary measuring equipment required for review of the Work.
- .4 Maintain a complete set of Contract Documents at all times for field reference by the Consultant.
- .5 Correct any deficiencies as they are reported during the performance of the Work.

1.18 Temporary Services

- .1 Provide temporary office, workshop and tools and material storage space for the Work and assume responsibility for any loss or damage thereto. Buildings erected for this purpose shall conform in appearance to those erected for similar purposes under other Divisions of Specification.
- .2 Provide temporary lighting for whole construction area. Coordinate with Contractor for requirements.
- .3 Provide scaffolding and shoring necessary for work of this Division. Scaffolding and shoring shall be adequate to protect the workmen according to Provincial and Local Regulations.
- .4 Provide rigging and millwrighting, labour and equipment necessary for the work of this Division. Employ only workmen well experienced and skilled in such trades for this portion of the work.
- .5 Provide hoisting machinery, operators, labour and materials necessary to lift and place equipment supplied under this Division.
- .6 The permanent systems or any part thereof shall not be used during construction for construction purposes, unless so permitted by the Owner, in writing.

Electrical General Requirements

1.19 Protection and Cleaning

- .1 Securely plug or cap open ends of electrical raceways or equipment to prevent entry of dirt, dust, debris, water, snow or ice.
- .2 Equipment stored on site shall be protected from weather and kept dry and clean at all times. Take care to avoid corrosion of metal parts.
- .3 Protect all finished and unfinished Work of this and other Divisions from damage due to carrying out of this Work.
- .4 Make good any damage caused directly or indirectly to walls, floors, ceilings, woodwork, brickwork, finishes, etc.
- .5 Before energizing any systems, inspect and clean the inside of all panelboards, switchgear and cabinets to ensure that they are completely free from dust and debris.
- .6 Clean all polished, painted and plated work. Clean all lighting fixtures. Remove all debris, surplus material and tools.
- .7 Carry out additional cleaning operations of systems as specified in other Sections of this Division and as Division 1 requirements.

1.20 Waste Management and Disposal

- .1 Separate and recycle waste materials.
- .2 Divert unused wiring and metal materials to metal recycling facility, or place in appropriate on-site bins for recycling in accordance with Contractor's requirements.

1.21 Mock-Ups and Trial Usage

- .1 Provide mock-ups in accordance with the conditions stated in the Contract Form and Division 1 of the Specifications.
- .2 Trial usage of any equipment or materials shall not be construed as evidence of acceptance of same and no claim for damage shall be made for injury to or breaking of any part of such work which may be so used.

1.22 Commissioning

- .1 Be responsible for commissioning of all work provided. The total commissioning requirements:
 - .1 Complete activation of all systems.
 - .2 Re-torquing of all bolted connections in all distribution equipment.
 - .3 Calibration, testing and verification of all systems.

Electrical General Requirements

- .2 Commissioning shall commence with activation and verification of all systems in accordance with requirements of the Specifications. This will include but not be limited to the following items to be tested, adjusted and verified:
 - .1 TVSS.
 - .2 Lighting and power distribution systems.
 - .3 Fire alarm systems.
 - .4 Emergency lighting system.
 - .5 Main switchboard
 - .6 Communication system
 - .7 Security systems
 - .8 Lighting Control System.

1.23 Testing

- .1 Carry out all tests specified and tests required by authorities having jurisdiction. The testing and adjusting is the responsibility of this Division.
- .2 Provide all equipment, labour, instruments, expenses of the manufacturer's representative, and incidentals, and pay for all power and fuel required to carry out the tests.
- .3 Submit the record of all tests and have these tests signed by Clerk of Works or Contractor's Superintendent and, where applicable the manufacturer's representative. Show in schedule form a record of the systems or parts of systems tested, the date of the test, the circumstances such as current, temperatures, etc., the duration of the test and any special remarks pertaining to events during the test. Note which tests have been witnessed by authorities having jurisdiction.
- .4 Submit certification letters from the manufacturers of all equipment certifying that their technical representatives have inspected and tested their equipment and are satisfied with the methods of installation and operation. Where existing systems are extended, provide letters covering both new and existing equipment and connections. These letters shall state the names of persons present at testing, methods used and a list of functions performed with location and room numbers where applicable.

1.24 inspection

- .1 Arrange for inspection of all Work by the authorities having jurisdiction. On completion of the Work furnish final unconditional certificates of approval by the inspection authorities.
- .2 Application for final review will be considered when the Work has been completed and written declarations submitted that all commissioning, testing adjustment, set up and documentation is complete. Final review shall be done when:
 - .1 All reported deficiencies have been corrected.

Electrical General Requirements

- .2 All systems have been balanced, tested, commissioned and are operational.
- .3 The Owner has been instructed in the operation and maintenance of all equipment.
- .4 All reports have been submitted and reviewed.
- .5 All maintenance manuals have been submitted and reviewed.
- .6 All tags and nameplates are in place and all data submitted and reviewed.
- .7 Cleaning up is finished in all respects.
- .8 All certificates are furnished.
- .9 All spare parts and replacement parts specified have been provided.
- .10 All record Drawings have been submitted and reviewed.

1.25 Demonstration and Instruction

- .1 Provide personnel, equipment and tools to demonstrate and instruct Owner's designated personnel in operation, controlling, adjusting, trouble-shooting and servicing of all systems and equipment to satisfaction of the Owner. This work shall take place during Owner's regular business hours prior to acceptance.
- .2 Where specified elsewhere in this Division, manufacturers shall provide demonstration and instructions.
- .3 Where specified elsewhere in this Division, manufacturers shall provide demonstration and instructions.
- .4 Where deemed necessary, the Consultant or Owner's agent may record these demonstrations via video tape or other means for future reference.

1.26 Warranty

- .1 Provide a written guarantee stating that systems, equipment, components, etc. have been installed to manufacturer's instructions, that systems meet the Contract requirements and that all deficiencies in material and labour occurring within two years after substantial completion, will be corrected at no charge.
- .2 Obtain Product warranties in excess of one (1) year from the manufacturer on behalf of the Owner. These Product warranties shall be issued by the manufacturer to the benefit of the Owner.
- .3 Instruct all manufacturers and suppliers that warranties on Products will commence at the date of Substantial Performance and not from the date the Products are put into operation.
- .4 All corrections to deficiencies listed in field review reports and other correspondence, as well as but not limited to those indicated in testing, adjusting, balancing and commissioning shall be completed prior to turn over.

Electrical General Requirements

1.27 Cash Allowance

- .1 Refer to Division 1 for Cash Allowance.

END OF SECTION

Basic Materials & Methods

PART 1 - GENERAL**1.1 General Requirements**

- .1 The General Conditions of CCDC 2 and the General Requirements of Division 1, form part of this section, and must be read in conjunction with the requirements of this section, and all related sections.
- .2 Work to be done under this Section shall include furnishings of labour, materials, and equipment required for installation, testing and putting into proper operation complete Electrical systems as shown, as specified and as otherwise required. Complete systems shall be left ready for continuous and efficient satisfactory operation.

1.2 Submittals

- .1 Submit Shop Drawings and Product data for Products specified in this section in accordance with Section 260100 – Electrical General Requirements.

1.3 Products

- .1 Products shall be new, of Canadian manufacture where available, first quality and uniform throughout. Submit tender based on the use of Products and equipment specified.
- .2 Electrical Products shall be C.S.A. approved and be so labeled. Products not C.S.A. approved shall receive acceptance for installation by Ontario Hydro Special Inspections Branch before delivery, and modifications and charges required for such acceptance shall be included in work of this Section. Products shall not be installed or connected to the source of electrical power until approval is obtained.
- .3 Where manufacturer is not specified provide Products of high commercial standard and quality consistent with the standards of these Specifications. Provide Products of same manufacture for like applications unless noted otherwise.
- .4 Products shall be designed and manufactured in accordance with latest issue of applicable Standards or Authorities when such are either mentioned herein, or have jurisdiction over such materials or items of equipment. Confirm capacity, ratings and characteristics of Products being provided to supply power to equipment provided under other Sections of the work. Resolve discrepancies before such items are purchased.
- .5 Acceptance of Products installed presumes that Products have not been damaged or exposed to conditions that would adversely affect performance and life expectancy. If in the opinion of the Consultant, Products have sustained damage, or have been exposed to abnormal conditions it shall be the responsibility of the Contractor to have such tests performed as deemed necessary by the Consultant to establish condition and therefore, acceptability of installed Products.

Basic Materials & Methods

PART 2 - PRODUCTS**2.1 Electrical Identification**

- .1 Outlet boxes
 - .1 Identify outlet boxes on the box cover with: circuits contained in the box, the panels from which they are fed, the voltage and purpose of the outlet.
- .2 Cable and conduit
 - .1 Identify conduits and cables for the various systems by the use of the following distinctive coloured labels. The Labels shall comprise pressure sensitive plastic tape with printing labels indicating the system. Apply a small area of paint to the outside and inside of each outlet box, pull box and panel as it is being installed. Identify junction boxes in suspended ceiling areas with colour on both inside and outside.
 - .1 120/208 volt system – yellow
 - .2 347/600 volt system – white
 - .3 Emergency power - orange
 - .4 Fire alarm systems – red
 - .5 Data cabling system – blue
 - .6 P.A./Telephone systems – grey
 - .7 Security/Intercom/CATV systems – black
 - .8 Other telecommunication systems - green
 - .2 Locate identification labels at follows:
 - .1 Behind each access.
 - .2 At each change of direction, at junction boxes, and at both ends of each run.
 - .3 At not more than 15m apart in straight runs.
 - .4 Where passing through a wall, partition, and floor. One on each side of wall, partition, and floor.
 - .3 Cable and conduit labels
 - .1 For power and lighting system feeders, install labels at either end of the conductors where terminated inside of equipment to match wiring diagram conductor identification or panelboard circuit numbers. Typical identification Panel AA circuit - 21; use "AA-21". For a three phase circuit provide identification on phase A conductor only. For a single phase circuit provide identification on the phase conductor.

Basic Materials & Methods

- .2 For lighting branch circuits identify circuit at panel and in outlet box connection to lighting fixture. Install label on phase conductor tap-off. Typical identification if fixture connected to Panel A, circuit 5; marker identification A-5.
- .3 For branch circuits supplying single phase and three phase devices such as receptacles and connections to equipment identify conductors at panel and in device outlet box. Install label on phase conductor inside outlet box. Typical identification if device is connected to Panel B - circuit 14, marker identification "B-14".
- .4 For switchboards identify all control conductors at terminal strips inside equipment and where terminated at all remote devices. Identification shall match numbering system on Drawings and "Reviewed" Shop Drawings.
- .5 For fire alarm systems, identify all conductors at terminal strips located in:
 - .1 Control panels.
 - .2 Annunciators.
 - .3 Printers.
 - .4 Local terminal cabinets.
 - .5 All remote devices.
 - .6 All connections in the system.
 - .7 Provide identification in accordance with the numbering system on the "Reviewed" Shop Drawings.
- .6 For miscellaneous systems identify all conductors at terminal strips located in:
 - .1 Control and/or monitoring panels.
 - .2 Control and/or monitoring stations.
 - .3 Local terminal cabinets.
 - .4 All remote devices.
 - .5 All connections in the system.
 - .6 Provide identification in accordance with the numbering system on the "Reviewed" Shop Drawings.
- .4 Equipment nameplates
 - .1 Provide lamaroid name plates, black background with white engraved letters 0.4" (10 mm) high, for electrical equipment but not limited to panels, switchboards, transformers, disconnect switches, breakers, contactors, relay panels, starters, TVSS, UPS, FACP and miscellaneous panels.
 - .2 Nameplates shall indicate voltage, capacity, upstream, and downstream equipment Typical identification for panel: "Lighting Panel C, 120/208 v, 3 phase, 4 W. Supplied from Panel BB".

Basic Materials & Methods

- .3 Switchboards - Plates to be mounted on face of switchboards. Typical identification for switchboard: "Switchboard AAA - 120/208 V, 3 phase, 4 W". Typical identification for branch feeders: "Power Panel BB".
- .4 Install plates after all painting has been completed. Secure with mechanical fastening devices except on the inside of panel doors where gluing will be acceptable.
- .5 Power system colour code
 - .1 Power system phase colour code:
 - .1 Red - Phase A
 - .2 Black - Phase B
 - .3 Blue - Phase C
 - .4 Neutral - White
 - .5 Ground - Green.
 - .2 Identify incoming utility service lines with enamel paint to above colour code.
 - .3 Band buses in switch board and panels to above colour code.
 - .4 Provide branch conductor to above colour code.
- .6 Manufacturer's nameplates
 - .1 Have the manufacturer's nameplates affixed to each item of all equipment showing the size, name of equipment, serial number and all information usually provided, including voltage, cycle, phase, horsepower, etc., and the name of the manufacturer and his address. Ensure that all stamped, etched or 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.
 - .2 Ensure that panels and other apparatus which have exposed faces in finished areas do not have any visible trade marks or other identifying symbols. Mount nameplates behind doors.
- .7 Signage
 - .1 Provide signage to local inspection authority on all equipment and electrical rooms.
 - .2 The suitable warning signs must be installed as per Electrical Safety Code.

Basic Materials & Methods

.8 Single line distribution Drawings

- .1 Provide clear acrylic covered framed as-built single line distribution system Drawing of the entire Project in the main electrical room. Distribution system shall be CAD generated. Size shall be minimum 305 x 460 mm with all text legible. Provide interim drawings until such time that permanent as-built drawings are available for permanent installation.

2.2 Wires and Cables

- .1 Comply with the requirements of the latest editions of the followings:
 - .1 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.
 - .2 CAN/CSA-C22.2 No.131 – Type TECK 90 Cable.
 - .3 CSA C22.2 No. 38, Thermoset Insulated Wires and Cables.
 - .4 CSA C22.2 No. 75, Thermoplastic-Insulated Wires and Cables
 - .5 CSA C22.2 No. 65, Wire Connectors.
- .2 Use copper conductors RW90, 600V, 90°C rated insulation unless otherwise noted.
- .3 Use RW90 X-Link, 1000V, minus 40 degree, 90°C rated insulation for 250MCM and larger.
- .4 Joints in feeder cables are not permitted.
- .5 Except as indicated hereinafter, wire for branch circuits to be #12 AWG except that #10 minimum to be used where the home run exceeds 27m (90').
- .6 Wires for power circuits to be #12 AWG minimum, and for control circuits to be #14 AWG minimum.
- .7 Solid conductors of #12AWG and smaller. Stranded conductors for #10 AWG and larger.
- .8 For wiring through or in lighting fixtures use type 'GTF' fixture wire, rated 600 volts to meet code requirements for recessed fixtures.
- .9 Wire to ceiling outlet boxes on which a lighting fixture is or may be mounted, with conductors having insulation suitable for 90°C.
- .10 Cables located in plenum, ceiling or floor spaces shall be totally enclosed in non-combustible conduit or raceway or be armoured cable where permitted by the Ontario Building Code.
- .11 Wires and cables for outdoor locations shall be minus 40°C rated.
- .12 Armoured cables shall be complete with interlocked aluminum armour, approved fastening and connectors and meet the requirements of Vertical Flame Test-Cables in Cable Tray of CSA C22.2 No. 0.3. The PVC jacket cables (TECK 90 and ACWU90) shall be FT6 rated.
- .13 Install all wiring in conduit, unless indicated as armoured. Route wire and cable to meet Project conditions. Use suitable cable fittings and connectors.

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- .14 Use an approved lubricant to assist in pulling conductors through conduit. Neatly train and lace wiring inside boxes, equipment and panelboards.
- .15 Balance the loading on feeders so that unbalanced load is less than 10%.
- .16 Limit the voltage drop at the end of feeders and branch circuits to 2% at the rated load of the circuit.
- .17 For single conductor armoured cables, where required to conform to the Electrical Safety Code, Rule 12-108, Bulletin 12-7-11.
- .18 Lighting fixture wiring in accessible ceiling spaces shall be run in conduit from the lighting panel to ceiling outlet boxes with armoured cable drops no longer than 3.0m (10 ft.) permissible from the boxes to fixtures.
- .19 Protect all exposed non-armoured cables in manholes, pull pits and trenches with an approved fire protective fibreglass tape of '3M' manufacture or approved equal. Extend the protective wrapping on the cables where they leave pull pits or trenches below switchgear to the circuit breaker or fused switch terminals. Rack cables in manholes and pull pits to provide clear access for maintenance and servicing.

2.3 RACEWAYS AND FITTING

- .1 Drawings do not show all raceways. Those shown are generally in diagrammatic form only.
- .2 Conform with the requirements of the latest editions of the following:
 - .1 CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
 - .2 CSA C22.2 No. 45, Rigid Metal Conduit.
 - .3 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .4 CSA C22.2 No. 62, Surface Raceways and Lighting Fixture Raceways and Fittings.
 - .5 CSA C22.2 No. 83, Electrical Metallic Tubing.
 - .6 CSA C22.2 No. 126, Cable Tray System.
 - .7 CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit.
 - .8 CAN/CSA C22.2 No. 227.3, Flexible Non-metallic Tubing.
 - .9 CSA C22 No. 18, Outlet Boxes, Conduits Boxes, Fittings and Associated Hardware.
- .3 Conduits
 - .1 Rigid steel conduit hot dip galvanized inside and outside installed:
 - .1 On the exterior of building;
 - .2 Where exposed to mechanical damage;
 - .3 Where conduits turn up or turn down out of concrete slab;
 - .4 Damp and wet locations.

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- .2 Steel galvanized electrical metallic tubing (EMT) installed:
 - .1 In partitions;
 - .2 In ceiling spaces;
 - .3 In service spaces.
 - .4 In masonry walls.
- .3 Rigid PVC (unplasticized) conduit except for exit light, emergency lighting, and fire alarm system installed:
 - .1 In slabs with rigid steel galvanized turn-up;
 - .2 Underground with rigid steel galvanized turn-up;
 - .3 In concrete walls;
- .4 Flexible armoured conduit:
 - .1 In partitions;
 - .2 For lighting fixture drops;
 - .3 From ceiling junction boxes into wall outlets;
 - .4 Flexible armoured conduits shall be limited to 10'-0" lengths where run horizontally from take-off junction boxes.
- .5 Liquid tight flexible conduit
 - .1 Final connection to motors.
 - .2 Any equipment which vibrates or generates noise.
- .6 For EMT use steel concrete tight set screw fittings. Die cast or pressure cast fittings are not acceptable. For rigid steel conduit use only steel or malleable iron threaded fittings. Threadless, die cast or pressure cast fittings are not acceptable.
- .7 ENT might be used where permitted by OESC, provided with mechanical protection as required by OESC.
- .8 Provide bushings on the ends of all conduits in enclosure, boxes, panels and cabinets, to protect the conductor installation. Except where grounding bushings are specified use all plastic insulated bushings temperature rating 150°C with double locknuts.
- .9 Use PVC conduit for all landscaping locations where conduit comes in contact with soil. Refer to Landscape Drawings for final elevation of planting soil. Co-ordinate and adjust electrical devices accordingly.
- .10 Conceal all conduits except in service spaces, mechanical rooms, electrical rooms and areas with ceilings.
- .11 Install all locknuts and bushings to ensure a secure mechanical and electrical bond. Use Erickson couplings in lieu of running threads.

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- .12 Where conduit joints occur in concrete, use silicone sealing compound to make water tight.
 - .13 Lay out conduit to drain free of all moisture.
 - .14 Securely hold conduits in place in concrete or masonry during pouring and construction operations; provide templates, forms and spacers as necessary.
 - .15 Support multiple runs of conduit on channel or angle iron with rod hangers.
 - .16 Secure all conduits in place with conduit clamps. Perforated pipe straps, wire lashings, wood screws or nails are not acceptable.
 - .17 Provide conduit expansion joints where conduits cross building expansion joints, also in straight runs of conduit 30 m (100') or longer. Conduit expansion joints shall be telescoping sleeve type, with insulated bushings and ground jumper.
 - .18 Make field bends and offsets uniform and symmetrical without flattening conduit. Minimum bending radius shall be ten (10) times the conduit diameter.
 - .19 Ream conduit ends to remove burrs and sharp edges. Fit conduit stubs with waterproof plastic caps during installation to protect threads and to prevent entrance of moisture into conduit.
 - .20 Test all conduits for clear bore using ball mandrel, brushes and snake. Clear any conduit which rejects the ball mandrel. Replace if necessary. Bear all costs involved in making all work good, restoring all surfaces to original condition.
 - .21 Install a continuous nylon cord 180 kg (400 lb) test in each conduit left empty.
 - .22 Install a copper ground conductor within the flexible conduit at each connection.
 - .23 Provide conduit seals in conduits which pass to the outside.
 - .24 Provide pull boxes, fittings or junction boxes in conduit runs, on the basis of not more than two (2) right angle bends or their equivalent or not more than 30 m (100'), in straight runs between boxes. For outdoor direct buried conduit, up to 50m.
 - .25 Size conduits to code requirements, provide larger sizes where noted.
 - .26 Size conduits for low voltage wiring to manufacturer's recommendations.
 - .27 Provide conduit sealing fittings and correspond for hazardous application to Electrical Safety code requirements.
 - .28 Maximum conduit size permitted in a concrete slab shall be 35 mm. In any case verify with Structural Consultant for acceptability.
 - .29 Where multi-conduits parallel run and/or crossover in concrete slab/wall, verify with Structural Consultant for acceptability.
- .4 Install raceways system complete with appropriate fittings such as connectors, bushings, elbows, couplings, locknuts, expansion fittings, fasteners and supports and accessories supplied as integral parts of assembly, as specified. Installation shall comply with Regulatory Authorities requirements.

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- .5 Neatly install exposed raceway running parallel to and at right angles to building lines and equally spaced in groups.
- .6 Keep raceway ends parallel and on proper spacing to suit knockouts or raceway openings in equipment or enclosure.
- .7 Keep raceways at least 150 mm clear of heating pipes, flues and hot item surfaces. Where required clearance cannot be provided, obtain written approval from Consultant to alter layout or to reduce clearance.
- .8 Provide expansion couplings, with bonding jumper and ground clamps where raceways cross building control joints.
- .9 Use only metallic, enclosed raceway on installation that required shielding of electrical cables or where installed in ceiling used as return air plenum, as specified or indicated on Drawings.
- .10 Raceways shall have established positive low resistance paths to ground and effectively isolate conductors so that any short-circuit arc is confined.
- .11 Select appropriate fittings, such as grounding bushings, bonding and grounding straps, to maintain continuity and effectiveness of grounding of raceway system.
- .12 Provide necessary fasteners and supports acceptable for type and size of raceways, to ensure rigid, complete assembly.
- .13 Provide suitable inserts or expansion type machine bolts for fastening raceways, fittings, boxes and equipment to concrete surfaces.
- .14 Do not use wood screws, lag screws, expansion shields, rawl plugs and nylon inserts.
- .15 Secure raceway and other associate work to structure members. Raceway shall not be supported from ceiling suspension system.
- .16 Thoroughly clean raceway and dry clear obstructions before pulling cable or wire.
- .17 Minimum raceway size: 16mm (1/2") conduit equivalent system.

2.4 Outlet and Conduit Boxes

- .1 Comply with the requirements of latest edition of the followings:
 - .1 CSA Standard C22.2 No.18, Outlet Boxes, Conduit Boxes and Fittings.
 - .2 CSA Standard C22.2 No. 85, Rigid PVC Boxes and Fittings.
- .2 Outlet and conduit boxes - general
 - .1 Size boxes in accordance with CSA C22.1.
 - .2 102mm square or larger outlet boxes as required for special devices.
 - .3 Gang boxes where wiring devices are grouped.
 - .4 Blank cover plates for boxes without wiring devices.
 - .5 347V outlet boxes for 347V switching devices.

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- .6 Combination ganged boxes with appropriate steel removable barriers where outlets for more than one system are grouped.
 - .7 Where standard make boxes are not suitable, provide boxes of special design to fit space and other requirements.
 - .8 Where vapour proof lighting is specified, provide matching vapour proof ceiling or wall junction boxes and fittings as required.
- .3 Sheet steel outlet boxes
- .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38mm or as indicated. 102mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
 - .2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48mm.
 - .3 102mm square or octagonal outlet boxes complete with steel fixture studs where supporting lighting fixtures. Die cast fittings not permitted.
 - .4 102mm square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster or tile walls.
- .4 Masonry boxes
- .1 Electro-galvanized stamped steel masonry single and multi gang boxes for devices flush mounted in exposed block walls, minimum size 95x 50 x 64mm standard and 102 x 57 x 61mm for 347V.
- .5 Concrete boxes
- .1 Electro-galvanized stamped steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.
- .6 Floor boxes
- .1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brushed aluminum faceplate. Device mounting plate to accommodate short or long ear receptacles. Minimum depth: 28mm for receptacles; 73mm for communication equipment.
 - .2 Rectangular: one, two, or three gang flush device floor boxes minimum size 110 x 81 x 70mm removable barriers for power/low voltage cables, complete with side and bottom knockouts.
 - .3 Multi-Outlet: Electro-galvanized stamped steel concrete type, combination power / communication, flush mounting complete with modular device plates, side and bottom knockouts, lift-up cast aluminum recessed cover and cable lid, black epoxy powder finished 229x257x76mm deep, or 64mm deep.
 - .4 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 16mm and 21mm conduit.

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- .5 Wiremold RFB Series. Alternate Manufacturers: Hubbell, Nocom, or approved alternate.
- .6 Refer to electrical drawings for more information regarding floor boxes and comply accordingly.
- .7 Conduit boxes
 - .1 Cast FS or FD aluminum, or ferrous boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles.
 - .2 PVC FS or FD boxes or PVC conduit where required in special corrosive areas as indicated on Drawing.
- .8 Fittings - general
 - .1 Bushing and connectors with nylon insulated throats.
 - .2 Knock-out fillers to prevent entry of debris.
 - .3 Conduit outlet bodies for conduit up to 35mm and pull boxes for larger conduits.
 - .4 Double locknuts and insulated bushings on sheet metal boxes.
- .9 Installation
 - .1 Support boxes independently of connecting conduits.
 - .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
 - .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come with 6 mm of opening.
 - .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
 - .5 Size and install appropriate boxes and enclosures in accordance with applicable section(s) of Ontario Hydro Electrical Safety Code and manufacturer's recommended procedures.
 - .6 Co-ordinate location and installation of boxes so as to be accessible and clear from building system equipment, etc.
 - .7 Install pull boxes in inconspicuous but accessible locations.
 - .8 Use pull boxes for conduits larger than 35mm. Use conduit outlet bodies for conduit 35mm.
 - .9 Provide approved hole plugs in unused conduit knockouts and openings.
 - .10 Furnish boxes and enclosures with corrosion resistant machine screws.
 - .11 Boxes and enclosures embedded in concrete for flush mounting, shall be secured properly with connecting conduits and related works set in place before concrete is poured. Forms, when used, shall be able to be removed without disturbing installed boxes or enclosures.

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- .12 Ensure junction and outlet boxes mounted in ceiling cavities do not interfere with removal of ceiling tiles.
- .13 Use masonry boxes for flush mounting in exposed block walls, concrete boxes for flush mounting in concrete wall.
- .14 Furnish conduit boxes with neoprene gaskets for outdoor area or hazardous area application.
- .15 Install all wall boxes for door security access devices, fire alarm devices, etc., adjacent to lock side of door openings unless otherwise shown. Check door swing before installing any switch.
- .16 Install all boxes in walls so that tapped holes for mounting wiring devices or fixtures will be aligned vertically or horizontally, as required. Where boxes are grouped at one location with common and varying mounting heights, align boxes horizontally and vertically from centre line unless otherwise indicated.
- .17 Offset outlet boxes in sound attenuating partitions to avoid undue transmission of sound between the partition elements. Use flexible conduit connections where wiring is required between outlet boxes on opposite sides of partition.
- .18 Offset outlet boxes where installed on either side of a fire separation.
- .19 Where steel supports are required for outlet boxes, wood supports are not acceptable.
- .20 Maintain integrity of vapour barriers along building perimeter wall where flush outlet boxes are required.

2.5 Contactors

- .1 Conform to the requirements of latest edition of CSA C22.2, No. 14 – Industrial Control Equipment.
- .2 Provide enclosed lighting contactors for all lighting control and other non-motor loads. The contactors shall be fully rated and withstand the large initial in-rush currents of lamps without contact welding.
- .3 Contactors shall be NEMA rated, magnetic, electrically operated, electrically held, complete with suitable type enclosure and 120V coil.
- .4 Fail open: contacts shall open upon the supply voltage drop below 75% of the rated voltage.
- .5 Accessories
 - .1 Pilot lights (ON/OFF).
 - .2 On/Off/Auto selector switch.
 - .3 Auxiliary contacts (NO and NC) and relays to match control function.
 - .4 Control circuit fuse-holders and fuses.

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- .5 Control transformers in each 347/600V enclosed contactor. Transformer shall be 120V secondary and furnished with primary and secondary fuses. Bond unfused leg of secondary to enclosure.
- .6 Manufacturers:
 - .1 Cutler-Hammer.
 - .2 Schneider.
 - .3 Siemens.
- .7 Mount contactors at 1500 mm AFF to operating handle/pushbutton.

2.6 Access Panels and Doors

- .1 in public areas should be Acudor DW-5015 or similar, ensure the specification requires the contractor to provide a shop drawing of the locations and sizes of access panels for consultant review.
- .2 In Back of house areas can be your standard specification, ensure the specification requires the contractor to provide a shop drawing of the locations and sizes of access panels for consultant review.
- .3 In lay-in ceilings, tiles properly marked may serve as access panels.
- .4 Provide the appropriate Division of Work with panels and doors, complete with frames and all pertinent information for installation. Arrange and pay for that Division to install them. Ensure that all panels and doors are flush mounted and properly aligned with building modules and grids. Indicate locations on record drawings.
- .5 Select all access panels and doors to provide adequate access, and to suit appropriate architectural finish, minimum size 150 mm x 150 mm (6" x 6"). Where necessary for persons to enter, provide minimum 600 mm x 450 mm (24" x 18") size doors.

2.7 Sprinkler Proof Equipment

- .1 Provide all equipment in sprinklered areas with accessories to prevent the entry of water into the enclosures in the event that the sprinkler system is activated.
- .2 Materials
 - .1 CSA enclosure type 2.
 - .2 Louvres facing outward and downward where openings are required for heat dissipation. Expanded metal screening is not acceptable.
 - .3 CSA certified sealing rings for rigid steel galvanized conduit and CSA certified raintight connectors for steel galvanized electrical metallic tubing (EMT) or other raceways as required.

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- .3 Provide seal rings and raintight connectors on all conduit terminations entering the top or side of all enclosures and for all conduit terminations for pull boxes, junction boxes, splitter troughs, wireways, auxiliary gutters, cable troughs and disconnect switches installed below the level of the sprinkler heads.
- .4 Refer to Mechanical Drawings for extent of sprinklered areas.

2.8 Backboards

- .1 Provide backboards for all surface mounted power distribution equipment. Provide backboards for telecommunication systems as indicated.
- .2 Backboards shall be minimum 0.76" (19mm) thick, good one (1) side fire retardant plywood backboards, pressure impregnated with fire retardant chemicals, and stamp. Conform to CSA 080.
- .3 Construct each backboard in a rectangular shape of the size as indicated. Where no size is indicated, provide a backboard a minimum 4" (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. Backboards for Telecommunication system shall be minimum 4" (W) x 8" (H).
- .4 Finish each backboard with one (1) coat of primer followed by a minimum of one (1) finish fire retardant coat of ASA 61 grey paint prior to installing any equipment.
- .5 Fastenings:
 - .1 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.
 - .2 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 Install fastenings a maximum 20" (500mm) apart in both the vertical and horizontal directions.
 - .4 When installing equipment heavier than 50kg, fasten the equipment through the backboard directly to the wall or support structure.

2.9 Metals

- .1 Metal construction required for the electrical work shown on the structural Drawings will be carried out by Division 5.
- .2 Provide all other electrical work such as, but not limited to, equipment bases, supports, catwalks, framework to support checker plates and electrical equipment above trenches and cable pits, ladders, etc. pit and trench covers, and as called for on the Electrical Drawings. Have such work carried out in accordance with the requirements of Division 5.

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2.10 Sleeves and Curbs

- .1 Provide conduit sleeves of galvanized steel for conduit and cable runs passing through concrete walls, beams, slabs and floor. Cut flush with finished surface.
- .2 Extend galvanized conduit sleeves for conduit rising through slabs 4" minimum above finished floors.
- .3 Through exterior walls below grade waterproofed floors, and other waterproof walls use heavy weight cast iron pipes machine cut. Extend sleeves 100 mm (4") above finished floors, and cut flush with underside of floor.
- .4 For rectangular duct openings for bus ducts and cable tray use minimum 18 gauge galvanized steel sleeves or provide a removable wood box-out of the required size. Brace sleeves to retain their position and shape during the pouring of concrete and other work.
- .5 Seal sleeves and openings to maintain fire rating. Use Fire Stop material as referenced in Section 01 33 00 Part 1.8 Project Firestopping Manual and coordination
- .6 Seal all openings and sleeves after installation of equipment:
 - .1 With an approved material to maintain fire rating where sleeves and openings pass through fire separations and floors.
 - .2 With an approved material to maintain fire rating for sleeves and openings provided for future equipment.
- .7 Size sleeves to provide 13 mm (1/2") clearance all around.
- .8 Provide all flashing and waterproofing for sleeves through roof and exterior walls to the requirements of Division 7, Thermal and Moisture Protection.
- .9 Except where furred in provide watertight concrete curbs, 100 mm (4") high by 100 mm (4") wide with 19 mm (3/4") chamfered edges around all sleeves and openings passing through waterproof floors.

2.11 Supports and Bases

- .1 Submit proposed method of attachment of hangers and beam clamps, to cellular steel deck for approval before proceeding with Work.
- .2 Supply and erect special structural Work required for the installation of electrical equipment. Provide anchor bolts and other fastenings unless noted otherwise. Mount equipment required to be suspended above floor level, where details are not shown, on a frame or platform bracketed from the wall or suspended from the ceiling. Carry supports to either the ceiling or the floor, or both as required, at locations where, because wall thickness is inadequate, it is not permitted to use such brackets.
- .3 Electrical panels, switches or other electrical equipment shall be complete with suitable bases or mounting brackets.
- .4 Provide channel or other metal supports where necessary, to adequately support lighting fixtures. Do not use wood unless wood forms part of the building structure.

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- .5 Secure supports, in general to structure, from inserts in concrete construction or from building structural steel beams, using beam clamps. Provide additional angle or channel steel members, required between beams for supporting conduits and cables.
- .6 Provide any additional supports required from existing concrete construction for any piping or equipment, by drilling same and installing expansion bolt cinch anchors.
- .7 Do not use explosive drive pins in any section of Work without obtaining prior approval.
- .8 Hangers for electrical conduit shall be galvanized after fabrication. Conduit hangers shall be as manufactured by:
 - .1 Burndy Canada Ltd.
 - .2 Canadian Strut Products Ltd.
 - .3 E. Myatt & Co. Ltd.
 - .4 Steel City Electric Co.
 - .5 Pilgrim
 - .6 Thomas & Betts
 - .7 B-line
- .9 Do not use, perforated strapping (grappler bars).
- .10 Steel supports in wet or dry locations to be galvanized after fabrication.
- .11 Provide concrete housekeeping pads or bases for all floor mounted equipment 100 mm (4") high with 19 mm (3/4") chamfered edges, keyed to the floor slab and extending at least 100 mm (4") on all sides of the equipment. Where draw-out truck type circuit breakers are provided extend pad to accommodate complete withdrawal of breaker. Provide and set all anchor bolts.
- .12 Use only factory made threaded or toggle type insert.
- .13 Place inserts only in structural members and not in the finishing material.
- .14 Provide bus ducts, cable trays, and wireways with fire barriers at each floor level and fire separation.
- .15 Provide locations and dimensions for all pads and curbs and provide and set all anchor bolts for all concrete work provided under Division 3, Concrete.

2.12 Spare Parts

- .1 Furnish spare parts and maintenance materials as recommended by the equipment manufacturer and as appropriate for a period of two (2) years after acceptance of the Work.

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PART 3 - EXECUTION**3.1 Neutrals and Phasing**

- .1 Provide one (1) identified grounded neutral conductor for each set of branch circuits connected to different mains of each panel.
- .2 For circuits identified as computer dedicated (D) or isolated ground (IG), provide individual neutral per identified circuit.
- .3 Install a separate neutral for each GFCI circuit when the GFCI is located at the panelboard.
- .4 Connect two or three (2 or 3) circuits sharing a common neutral to different mains or phases.
- .5 Balance the connected loads across the mains of each panel to within 15%.
- .6 Circuit numbers on the panels must correspond to the numbers on the Drawings.
- .7 Connections in all equipment to be Phase A, B and C from left to right, and front to back when viewing from the front or accessible direction.

3.2 Mounting Heights

- .1 Mounting heights are from floor level to centre line of device outlet, unless noted otherwise. In all areas accessible to persons in wheelchairs, the mounting heights of all switches, thermostats, intercom switches, pull stations, etc., required by Building Code "Barrier Free" shall comply with OBC Code requirements. Mounting height shall meet FADM requirements.
- .2 The mounting heights of all power and lighting devices shall comply with Ontario Electrical Safety Code requirements. The mounting heights of all fire alarm devices shall comply with CSA requirements.
- .3 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .4 Install electrical equipment at following heights (centre of device) unless indicated otherwise:
 - .1 Wall switches, dimmers, timers, speed controllers, speaker volume controllers, thermostats and hand dryers: 1100 mm.
 - .2 Wall receptacles:
 - General: 450 mm.
 - Above top of continuous baseboard heater: 250 mm minimum.
 - Above top of counters or counter splash backs: 250 mm.
 - In mechanical rooms: 1100 mm. (gang with switch)
 - .3 Panelboards: as required by Code or as indicated.
 - .4 Telephone, TV and data outlets: 450 mm.
 - .5 Door bell pushbuttons and door open push buttons: 1100 mm.

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- .6 Intercom switches: 1100mm.
- .7 Security wall-mounted motion sensor: 2300mm.
- .5 Install all fire alarm equipment/devices in accordance with CAN/ULC-S524 "Standard for the Installation of Fire Alarm Systems" latest edition, the manufacturer's instructions, Ontario Building Code, Underwriter's Laboratory of Canada, Electrical Safety Code, these Documents and requirements of Local Authority Having Jurisdiction.

3.3 Wiring of Mechanical Equipment

- .1 Co-ordinate all the work with Division 23. The locations of starters, motors and associated equipment indicated on the Drawings are approximate and diagrammatic only. Co-ordinate with the work of the Mechanical Division Trade Sections to ensure proper location of equipment. The exact locations of conduit terminations at Mechanical units shall be determined from equipment manufactures' approved Shop Drawings. Conduits must be installed to enter only in the locations designated by equipment manufactures.
- .2 Provide all electric baseboard heaters, cabinet heaters, force flow unit heaters and heating cables. Mechanical Division shall provide electric duct heaters.
- .3 Provide safety disconnect switches required at motors by OESC whether shown on the Drawings or not. Provide power wires and connections to all mechanical equipment.
- .4 All the motor starters/controllers, and/or line voltage thermostats shall be supplied by Mechanical Division and installed by Division 26. Division 26 shall provide safety disconnect switches and power connections to the motors. Mechanical Division shall provide all the control wiring, control devices and low voltage thermostats.
- .5 Where motor starters, switches and the like, are grouped together, provide suitable plywood backboard to which all such equipment shall be secured.
- .6 Where the single-phase exhaust fan shall be controlled by manual switch, Division 26 shall provide power connections to the fan, heavy-duty toggle control switch and provide the safety disconnect means.
- .7 Wiring and connections from fire alarm system to motor starters/control panels for motor control operations. Co-ordinate with Mechanical Division.
- .8 Where applicable, power supplies to MCC. Mechanical Division will provide MCC, main lugs, power supplies and controls to motors.
- .9 Fire alarm signals to starters / control panels and MCC.

3.4 Services to Equipment Supplied by Owner / Other Divisions

- .1 Provide all necessary connections required for equipment supplied by the Owner and other Divisions. Examine all Drawings and Specifications and identify all requirements.
- .2 Verify the type, rating and location of all outlets and/or connections required for all equipment provided by the Owner and other Divisions.

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- .3 Provide isolation devices as required to the equipment for all services.

3.5 Provision for Future Equipment and Construction

- .1 Spaces designated for future equipment or building expansion shall be left clear.
- .2 Provide services for future extensions complete with Products necessary for present termination and to permit future extension.
- .3 Identify each service by a permanent marker at its termination point.

3.6 Cutting and Patching

- .1 Provide all cutting and patching required for the Work of Division 26. Work shall be carried out in conformance with the requirements of Division 2. Include any radiography required to locate concealed services before penetrating into inaccessible locations.
- .2 Any modifications to building shall be done so as not to diminish structural, fire resistance, or smoke barrier integrity.
- .3 Proposed modifications to structure shall require acceptance by the Structural Consultant.
- .4 Consultant shall be afforded the opportunity to review the intent prior to any major cutting.

3.7 PAINTING

- .1 Provide all exposed ferrous metal work, and Products, except conduit, 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 9, Finishes of these Specifications.
- .2 If not factory coated, clean, wire brush and paint all ferrous supports and hangers concealed in ceiling spaces of kitchens or other similar high humidity areas. Do not paint galvanized supports and hangers.
- .3 Repaint or refinish all damaged factory applied finishes.
- .4 Provide oil base red oxide primer applied as per manufacturer's recommendations.

3.8 Vibration and Noise Control

- .1 Spring type vibration isolations shall be complete with horizontal spring constant (kH) to vertical (kV) ratio between one and two to assure stability. Select springs to operate no greater than 2/3 solid deflection. For indoor mounting use springs with one (1) coat of zinc chromate primer and two (2) coats of paint. For outdoor mounting use springs of neoprene coated steel or stainless steel. All spring housings to be hot dipped galvanized. Where the spring assembly is bolted to the floor provide vibration isolation washers and pads to reduce transmission of vibration.

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- .2 Pad type isolators shall be rubber for indoor application, neoprene for oil filled devices and for outdoor use. Use 30 durometer rubber and 50 durometer neoprene. Select pad type isolators which do not exceed the mid-point of their recommended operating rate with maximum deflection of 20% of thickness. Use minimum 6 mm (1/4") thick pads under spring assemblies.
- .3 Provide spring type vibration isolators for IC engine driven equipment. Raise equipment to operating height, levelled with blocks and shims so that connections can be made to a rigid system at operating level before isolator adjustments.
- .4 For power class transformers provide spring or pad type isolators in accordance with the manufacturer's recommendations. Where dry type transformers are contained within unit substation enclosures mount the core and coils to the structural framing of the unit substation. Locate isolators between core and coil frame and unit substation structural frame.
- .5 Provide pad type isolators for all floor mounted dry type distribution transformers. Locate isolators between transformer enclosure and floor.
- .6 Where transformers are platform mounted from structure above provide spring hangers with levelling devices and sound pads in all supports.
- .7 Make connections to rotating, vibrating, magnetic or other noise producing equipment such as motors, transformers, and between independent structure by means of loop flexible conduits.
- .8 If objectionable noise or vibration should be transmitted to occupied portions of the building by any part of the electrical work, make necessary changes and/or additions, to the Consultant's approval, without addition to the contract price.
- .9 Cable trays, conduit, buss bars, raceways or other connections shall be either flexible connected to vibration isolated equipment or vibration isolated per above for a minimum of 9100 mm (30 ft) from the equipment. If a flexible connection is used, it must accommodate without the strain the full range of anticipated movement of the isolated equipment.

3.9 Concrete

- .1 Concrete work shown on the structural drawings will be done as part of Division 3, Concrete of these Specifications.
- .2 Provide all other concrete work necessary for the Work of this Division. Have such work carried out in accordance with Division 3, Concrete of these Specifications.

3.10 Excavation and Backfilling

- .1 Before commencement of excavation of the Work, determine with the Consultant, the municipalities and utilities, the presence of existing underground services at the site and verify satisfactory condition. Locate such services and mark out same. Ensure that all trades concerned are aware of their presence.

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- .2 Do all excavation and backfilling up to grade required for the electrical work inside and outside of building. Check available soil test reports. Obtain instructions of the Consultant regarding the type of soils and their extent.
- .3 Carry out all trench excavation in strict conformity with all applicable acts and bylaws.
- .4 Excavate to the required depth and width. Backfill excess excavation.
- .5 For direct buried cable in all soil conditions excavate to 150 mm (6") below and a minimum of 200 mm (8") to either side of the cable run. Fill back with a bedding of granular 'A' gravel or sand.
- .6 Provide ducts under roads and paved areas.
- .7 Refer to details and to Utility Company requirements for concrete encased duct installations.
- .8 Where excavation is necessary in proximity to and below the level of any footing, provide a sleeve at the proximity and backfill with 14,000 kPa (2,000 psi) concrete to the level of the highest adjacent footing. Proximity is determined by the angle of repose as established by the Consultant.
- .9 Protect the bottom of excavations against flooding and freezing. Use pumping or other means to keep bottom dry. Do not open more than weather will permit. Have excavations inspected at least once a week by authorities. Break up rocks and boulders and remove these by drilling and wedging. Do not use blasting unless approved in writing by the Consultant.
- .10 Compact all backfill to a density of 95% Modified Proctor. Before backfilling, obtain approval. Remove all shoring during backfilling. Obtain approval for all compaction machines used.
- .11 Backfill trenches within building, with clean sharp sand in individual layers of maximum 150 mm (6") thickness. Manually compact the first layers up to a compacted level of 300 mm (12"). Machine compact the balance up to grade, using approved equipment.
- .12 Backfill trenches outside buildings, not under roads, parking lots, or traffic areas, manually compact up to a compacted level of 450 mm (18") above the cable or duct bank with individual layers of material up to 150 mm (6") thick, using sand or granular 'A' gravel. Machine compact the balance up to grade with 150 mm (6") layers of approved excavated material.
- .13 Backfill all other trenches outside buildings with granular 'A' gravel in layers not exceeding 150 mm (6") thickness, up to grade level; manually compact up to 450 mm (18"), machine compact the balance.
- .14 Do not use water for consolidation or during compaction of backfill, unless approved in writing by the Consultant.
- .15 After a period has passed adequate to reveal any settlement fill all depressions to correct grade level with appropriate material, machine compacted. Pay all costs required to make good all damage caused by settlement.

Basic Materials & Methods

- .16 Store and dispose of excavated materials as follows:
 - .1 During the progress of the contract place the material as directed in such a manner that a minimum of damage or disfigurement of the existing ground will result and the material will not in any way impede the progress of the work. Dispose of surplus material as directed by the Consultant.
 - .2 Place surplus topsoil separately from subsoil. Leave the site clear and unencumbered.
 - .3 Protect, brace, support as required existing pipes, ducts, cables, etc. encountered in the work. Do not disturb or interrupt the operation of any services without written approval from the Consultant.

3.11 Concrete Encased Duct Banks

- .1 Provide PVC duct runs consisting of parallel ducts encased in concrete as indicated on drawings.
- .2 Ducts and concrete encasement for Power Supply Authority service cables shall conform with their standards and requirements.
- .3 Place and set all ducts and accessories and supervise to ensure integrity of complete installation.
- .4 Conform with the requirements of the latest editions of CSA 22.2 No. 211.1, Rigid Types EB1 and DB2/ES2 PVC Conduit.
- .5 Join ducts together with an approved coupling to provide a sound and watertight joint. Stagger joints in adjacent ducts by not less than 200 mm (8"). Where PVC and bell fittings are used make connections to duct with an approved PVC solvent.
- .6 Install ducts with spacing of not less than 190 mm centre to centre both horizontally and vertically. Use only plastic or masonry spacers. Provide two (2) spacers minimum per 3000 mm (120") length of duct.
- .7 Grade ducts not less than 75 mm (3") per 30 m (100') for drainage and provide drainage facilities as detailed.
- .8 Encase ducts with 3000 pound concrete with a minimum cover of 75 mm (3") on all sides using pea gravel aggregate. Work concrete below and between ducts to product a homogeneous mass. Provide reinforcing steel. Anchor all ducts in place in such a manner as to ensure that there is no movement during the placing of concrete.
- .9 Immediately after concrete has been placed test each duct with a mandrel not less than 300 mm (12") long and having a diameter 7 mm (1/4") less than the diameter of the duct. After all obstructions have been cleared pull a stiff bristle brush through each duct to remove all sand and other foreign material. Install a 225 kilogram (500 lb) test rope or other equivalent non-metallic cord in each duct and seal all ends with standard plastic duct plugs.
- .10 Provide end bell fittings at duct bank finished end face.

END OF SECTION

Digital Metering

PART 1 - GENERAL**1.1 General**

- .1 All Division 26 general and specific requirements apply to all electrical bidders, as do the requirements of this subsection, utilities submetering system. Purchase/supply and installation of mechanical meters (water, natural gas, BTUs, fluid, etc.) to be provided by Division 21, 23 and 25 mechanical bidders as a supplement to the electrical install price for the submetering system. The design criteria for the Digital Metering System is based on the CARMA Metering Manager System as manufactured by CARMA CORP. The Contractor shall be responsible for all costs associated for proceeding with an acceptable alternate manufacturer as listed in this specification for a fully operational system.

1.2 References

- .1 Division 260100 - Electrical General Provisions
- .2 Division 210501 - Mechanical General Provisions

1.3 Related Work

- .1 Division 224201 - Water Check Meter
- .2 Division 231123 - Natural Gas Check Meter
- .3 Division 253001 – BTU Energy Check Meter

1.4 Standards

- .1 Except as noted by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the Canadian Electrical Manufacturer's
- .2 Approved by Measurement Canada (department of ISED Canada) complete with notice of approval (e.g. AE-####, AV-####, AG-####) as legal for sub-metering.
- .3 Meets Canadian Standards based on UL 61010 and is certified and/or SPE-1000 inspected. Compliant with ISED Canada wired and wireless telecommunications requirements (similar to FCC part 15).

1.5 Description of Work

- .1 Provide complete, working, computer based digital metering system (DMS) to break down and track Electricity, Natural Gas, BTU Energy and Water measurements of the building. The DMS will be used to achieve the LEED Measurement and Verification credit.
- .2 The DMS price will include all costs associated with the co-ordination of system installation, material supply, commissioning, installation verification, and customer training during the entire period of construction and system start-up.
- .3 The total number of electrical meters to be monitored by the DMS shall be as shown on the electrical drawings.

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- .4 The total number of mechanical metering points to be monitored by the DMS shall be as shown on the mechanical and electrical drawings.
- .5 The electrical contractor will provide all labour, equipment, materials and services and install all interconnecting wire and conduit required for the Supplier's and/or Owner's digital metering system(DMS) including the conduits and wiring to the electric, water, natural gas and BTU energy meters.
- .6 Provide current transformers (CTs) and potential transformers (PTs) as required by meters.
- .7 The DMS supplier is responsible for integration of water, BTU energy and gas meters, specification confirmed by Mechanical Consultant and supplied by mechanical contractor.
- .8 The DMS Supplier will provide a detailed installation manual to the electrical subcontractor, which recognizes all applicable codes and requires final electrical as-built documentation.

1.6 Work and Materials Included by Carma Corp. – The Meter Manager™ System Supplier

- .1 Supply, test and commission a METER MANAGER™ computer based electronic utilities submetering system as specified herein and shown on the Drawings.
- .2 The System is to include submetering data collection and communications with a Central PC and billing software or Local Display integral to the Field Panel.
- .3 The System is to be capable of handling a minimum of 2000 utility submetering points which include Electricity, Natural Gas, Water, Fluid Flow and BTU Measurement.
- .4 The System will be complete with all necessary:
 - .1 Electronic Field Panels - Energy Monitoring Pods (EMP), Data Collection Units (DCU) and Profilers (Pulse Totalizers);
 - .2 Current Transducers (CT);
 - .3 5AMP Step-Down Current Transformers (SDCT) and Meter Interface Devices (MID);
 - .4 Potential Transformers (PT);
 - .5 System Software;
 - .6 Network Interfaces and Network Repeaters;
 - .7 Integration of pulse output water, gas, fluid flow or BTU meters (form A (or C) contact closure or driven pulse type) [specification confirmed by Mechanical Consultant and supplied by mechanical contractor]
- .5 The System Suppliers' price will include all costs associated with the co-ordination of system installation, material supply, commissioning, installation verification, and customer training during the entire period of construction and system start-up.

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- .6 The System Supplier will provide a detailed installation manual to the electrical subcontractor, which recognizes all applicable codes and requires final electrical as-built documentation.
- .7 The System Supplier will include in the price all costs associated with Measurement Canada Bench Verification and Sealing, which confirms Measurement Canada Approval and for CSA inspection and certification. For electricity, Measurement Canada’s minimum accuracy standard is 0.5% applicable at unity power factor, throughout the specified range of each current transducer and step-down current transformer. Electricity meters are required for electrically powered mechanical loads such as Air Handler Units, Chillers, etc.
- .8 The System Supplier shall include in the price all costs associated with Measurement Canada installation inspection and verification for all submeters. Installation inspection certificates shall be included in the as-built documents.

1.7 Work and Materials Included by the Electrical Contractor

.1 ELECTRICAL CONTRACTOR RESPONSIBILITIES

Legend	
CT: Current (to-Voltage) Transducer (6.2V Output)	PT: Potential Transformer
SDCT: Step-down Current Transformer (5A Output)	EMP: Energy Monitoring Pod
MID: Meter Interface Device (5 A Transducers)	DCU: Data Collection Unit
Carma 422-LAN: RS-422 Local Area Network	Ethernet/WAN: Internet Based Networks
PMD: Pulse-Output Meter Device (water, gas, BTU)	Profiler: Pulse Totalizing Panel

NOTE: It is the Electrical Contractor’s responsibility to ensure all Electrical Codes and Safety Regulations (CSA/UL) are followed in the installation.

Equipment:

Supply All:

- .1 Conduit for communications network cable and CT and PT leads.
- .2 Interconnecting cables: Carma-422LAN, CT or PT lead extensions if required (CTs and PTs come with 10 ft. (600V) leads). Acceptable types include: Beldon 8777 (300V), Provo FT4-1753-Stranded (600V), Provo FT6-991753-Stranded (600V). CAT-5 cable will be required for Ethernet systems. Single twisted-pair #22 cable for terminating PMDs to Profilers.
- .3 Connectors, fasteners and junction boxes for conduit, connectors for cable splices.
- .4 Additional PT fuse blocks and fuses if PTs not installed within 10 ft (3m) of source. PT fuse block should be separately breakered at source and locked-on.
- .5 Supply 12 gauge wire for powering PT fuse block and SDCT current loops. See note below. Connections at splices must be crimped.

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Performance of Installation:

- .6 Install and terminate communications cable between all network devices. This may also require connection to an onsite computer (or DCU). [Carma Technician will make the final connection to computer, but cable must be brought to computer (or into DCU) by installer]
- .7 Provide a dedicated 120VAC circuit for EMPs, Profilers, Repeaters and/or DCUs/Main Computer.
- .8 Mount any EMPs, Repeaters, Profilers, and DCUs (away from vibration or water threat)
- .9 Install PTs and connect each to the proper phase as per the EMP wiring chart using colour coded (red/black/blue) wire on the line side of the fuse blocks. PTs must be installed within 10 ft (3m) of their power source unless the line is fused at 15A or less.
- .10 Ensure conductors from PT fuse block to source or 5A SDCT current loop Do Not Pass Through CTs.
- .11 Hang all CTs on insulated conductors (and secured as required), phases corresponding to their assigned PTs, as per the EMP wiring chart, including verification of phase between PTs and CTs, and phase tape conductors.
- .12 Pre-inspect, measure physical spacing and identify model number (size) step-down current transformers (SDCTs). SDCTs are used for critical services or services over 400A.
- .13 Install any SDCTs (per above) and Meter Interface Devices/5AMP Transducers required, including shorting terminals with each current transformer (provided by TB2 in MID), using colour coded wiring from the current transformer to the shorting terminal and further to the transducer terminals (see MID installation figures for colour code and connections).
- .14 Terminate CT/PT/PMD leads on correct terminals of EMP/Profiler sensor board (as per EMP wiring chart) and, where necessary, extend leads with proper cable (as per "C" in Equipment above)
- .15 Ensure that EMP/PT/MID enclosures are not used as "Raceways" for other wiring
- .16 Ensure that the white dot (H1) on the CTs/SDCTs points toward the power source and that all CT/PT leads are connected to sensor boards according to the lead colours specified on the wiring charts.
- .17 Ground CT/PT lead extension shields at EMP only (network shield only grounded at computer)
- .18 Provide details of physical locations of PTs/CTs/SDCTs in building and identify power sources for auxiliary EMP powers in Carma As-Built Forms
- .19 Ensure that CTs/SDCTs and PTs are accessible with identification tags visible, serial numbers facing outward, for installation inspection purposes by Measurement Canada personnel

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- .20 Additional Requirements: Comply with all requirements identified in the Meter Manager™ Installation Manual, Measurement Canada Specification PS-E-04-E and 100% accurate and complete As-builts

1.8 Submittals

- .1 Submit dimensioned drawings and manufacturers' data of the DMS components including but not limited to digital meter, pulse data logger, network controller, meter enclosure
- .2 Submit shop drawings in accordance with Division 26 – Electrical General Provisions & 23 – Mechanical General Provisions for:
- .3 Verification credit EAc5.
 - .1 Interconnecting wiring diagram for the completely installed DMS.
 - .2 Data sheets for each system component.
 - .3 Operation and Maintenance manual.
- .4 Shop drawings must be submitted to Jain Consultants for review. Any deficiencies in the shop drawings must be resolved in order to achieve the LEED Measurement and Verification credit EAc5.
- .5 Submit shop drawings and manufacturer's data for the component items shown and specified under this section of the specification. Do not supply any equipment to this project prior to shop drawing review by the Consultant. Shop drawings shall be stamped and signed by the Contractor prior to submittal.
- .6 Submit a one-line diagram of the proposed system configuration for review.
- .7 After shop drawing review, the Approved Drawings will be issued to the Electrical and Mechanical Contractor(s) for installation.
- .8 At the completion of the Project, As-Built Drawings will be submitted by the DMS Supplier, who will prepare a complete manufacturer's manual including all As-Built Wiring Diagrams.

1.9 Commissioning & Training

- .1 After completion of the system testing, the Manufacturer shall conduct training of the Owner's operating and maintenance staff. Training will include both hardware items and computerized system operation.

1.10 Certification and Approvals

- .1 Measurement Canada approvals will consist of "Approval of Type" documentation submitted to the Consulting Engineer at the time of Tender closing as issued by Measurement Canada in Ottawa. Bench Verification of each submetering system device will be conducted by Accredited Measurement Canada Inspectors. Measurement Canada (a department of Industry Canada) enforces measurement of all commodities listed under the Electricity & Gas Act and Weights & Measures Act.

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- .2 Measurement Canada Seals will be affixed to each field metering panel and shown to the final inspection Consultant.
- .3 Completion of on-site installation inspection and verification will be required by Measurement Canada under Specification PS-E-04
- .4 CSA approvals and panel stickers will be visible on each field panel.

1.11 Submetering System Requirements

The following requirements must be functional capabilities of the submetering system at the time of Tender Closing. All requirements will be fully enabled for every meter.

- .1 Operation
 - .1 Shall provide automated monitoring and recording of Electrical, Services through a hardwired communications trunk cable. Measure and report energy consumption and demand of all electrical and mechanical meters installed and connected for:
 - .1 Electricity – specified by Electrical Engineering Consultant and/or CARMA CORP.
 - .1 3 phase, 4 wire 120, 240, 277 & 347 VAC
 - .2 2 phase, 3 wire 120/208VAC and “single-phase” residential 3-wire 120/240VAC
 - .3 3 phase, 3 wire (delta connected) 416, 480 & 600 VAC
 - .2 Shall provide Windows™ based software to accommodate blended utility rate structures including up to (24) twenty-four distinct daily intervals and (4) four seasonal registers for Time of Use and Tenant Meter. Provide for the generation of individual, custom Tenant Bills showing a clear breakdown of the calculations incorporated to allocate the main monthly utility invoice, Time of Use and Consumption to each Tenant.
 - .3 Shall permit totalizing of kWh and Demand measures (electricity) within the software, from any number of metering points and any meter groups required.
 - .4 Shall store 15-minute consumption and demand interval power measurement data for each meter, in non-volatile memory located in all field metering panels (Energy Monitoring Pods and Profilers), for a minimum period of 35 days.
 - .5 Shall permit the following data to be transmitted from all metering points to the Central Computer for legal billing:
 - .1 Meter address;
 - .2 Electricity
 - .1 kWh (accumulated);
 - .2 Peak kW (demand) since last reset;
 - .3 Peak kVA (demand) since last reset.

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- .3 Mechanical
 - .1 Usage (accumulated);
 - .2 Peak Interval Usage (demand);
 - .4 15-minute interval data for construction of the Coincident Demand measures.
- .2 Supervision
 - .1 Shall run continuous self-diagnostics on the system and report on any tampering, communication interruptions and/or power failures.
 - .2 Shall provide password protection within the system software, with three levels of controllable access:
 - .1 Supervisor;
 - .2 Manager;
 - .3 User.
- .3 Communication
 - .1 Shall be via a twisted, shielded 3-pair 22-AWG cable (i.e. Belden #8777) cable interconnecting the Electronic Field Panels and repeaters to the Central Computer, following recognized industry standard requirements for the installation of a multi-drop linear communications (network) trunk cable.

PART 2 - PRODUCTS

2.1 Drivers for Led Fixtures

- .1 Electronic Driver for LED Fixtures: Comply with UL 1310 Class 2 requirements for dry and damp locations. Include the following features unless otherwise indicated:

2.2 Electronic Field Panels

All submetering system panels and enclosures will be CSA approved and will display CSA approval labels.

- .1 Units shall:
 - .1 Be supplied in enclosures suitable for surface wall mounting and shall be complete with knockouts for conduit entry.
 - .2 Contain a non-volatile memory;
 - .3 Be tamper-proof;
 - .4 Be complete with automatic self test and diagnostic features;
 - .5 Contain a crystal based clock for the accurate calculation of kWh and demand intervals;
 - .6 Have a unique individual address;
 - .7 Be designed to retrieve information from field devices up to 2000 feet away;

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- .8 Provide connections for local interrogation of the unit utilizing a laptop computer;
 - .1 Be bench verified and sealed by Measurement Canada for legalized submetering.
 - .2 Allow Measurement Canada Approved field panel electronics to be fully removable without disconnecting any electrical terminations.

2.3 Energy Monitoring Pods (EMP)

- .1 Units shall:
 - .1 Be designed to measure and transmit Instantaneous RMS voltage and amperage for each phase;
 - .2 Be designed to measure and transmit Instantaneous, present and peak kW, kVA demand for the purposes of power-factor measurement (features enabled for whole building or large loads as required);
 - .3 Be designed to measure and transmit kWh energy consumption on a minimum of 1 reading per day (or 24 readings per day for Time of Use applications). Meters may be read faster by a logger through building automation interface (as required)
 - .4 Be equipped with terminal blocks to accommodate all necessary connections for current transducers, potential transformers and communication cables. For larger step-down current transformers, terminal blocks shall be complete with shorting connections.
 - .5 Optionally, provide 100% additional spare meters for future expansion of the system. Spare meters will be installed evenly throughout the Project. Spare meters will be mounted in electrical rooms, supplied with 120 volt grounded power and referenced to potential transformers installed in the same locations. Step-down Current transformers & current transducers will be provided as required.

2.4 Current Transducers and Step-Down Current Transformers

- .1 Sized to accommodate the following electrical service sizes:
 - .1 100 amperes;
 - .2 200 amperes;
 - .3 400 amperes.
- .2 Certified by Measurement Canada for legalized Tenant Revenue-Billing.
- .3 For services larger than 400 amperes, Measurement Canada Approved step-down current transformers, each with a 5 ampere secondary will be provided with the required interface to the submetering system. A meter interface device shall expedite the meter commissioning without tools or the need for a power shutdown.

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- .4 To be equipped with pre-wired leads, three (3) metres in length, on all Current Transducers sized at 400 amps or smaller.

2.5 Potential Transformers

- .1 Shall be suitable for voltage ratings required for the electrical system operation.
- .2 Shall be certified by Measurement Canada for legalized submetering.
- .3 Shall be factory assembled and mounted in separate enclosures complete with electrical disconnects and fuses.

2.6 System Software

- .1 Provide a Windows™ based simplified user interface for system operation.
- .2 Revenue legal metering measurements shall be received from all submetering sensors and stored in a central Data Collection Unit (DCU) or PC in comma separated variable (CSV) file format.
- .3 To monitor, acknowledge and control communications with the remote metering points and to log any disruption of the communication link or unauthorized system access or tampering.
- .4 The system must be capable of storing all meter data for at least 36-months
- .5 All meters on the system must be capable of reporting hourly, daily, monthly and annually for their energy/utility usage
- .6 To permit the user to view instantaneous readings of voltage, current, power, phase angle, present and peak demand for any electricity meter.
- .7 To permit the user to view instantaneous readings present usage (totalized) or demand (last 15 minute interval) for any mechanical meter.
- .8 Provide the ability to export data into Reporting Applications (e.g. Web and Excel VBA).
- .9 To include service menus for diagnostic monitoring of the metering equipment and through either a modem and telephone link or Internet access to permit remote diagnostics by the manufacturer's service technicians. Security access control shall permit remote diagnosis to be locked out.
- .10 Data must be remotely accessible.

2.7 Output File Format & Storage

- .1 Data shall be recorded every 15 minutes.
- .2 Data shall be provided in comma separated value (.CSV) files.
- .3 Each row in the output file shall represent a successive sample time.
- .4 Include a time stamp for each line in the file.
- .5 Separate each field by a single comma character.

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- .6 Each required monitoring point shall contain a unique and understandable identifier.
- .7 Each required monitoring point shall contain a unique and understandable column.
- .8 All output files are to follow the format shown in Appendix B as closely as possible.
- .9 Provide a sample output data file a minimum of 1 month prior to building occupancy.
- .10 Provide data files to the Owner and LEED® consultant in electronic format.

2.8 Data Storage and Logging Requirements

- .1 System shall be capable of storing data for a minimum of 250 DMS points (where power and energy measurements are equivalent to one point) for period of no less than 15 months.

2.9 Pulse Data Recorder/Pulse Totalizer (Profiler)

- .1 Units shall:
 - .2 Be capable of counting pulse inputs from eight (8) independent sources such as gas, water and electricity meters at up to 10 pulses per second (10 Hz).
 - .3 Date, time stamp and store up to 30-days of 15-minute utilities interval data for all 8 channels.
 - .4 Be designed to communicate on Modbus, RS-422 or RS-485 Local Area Network or stand alone through an on board dial up modem, Ethernet or wireless Ethernet 802.11b/g interface by a PC running digital metering software to retrieve interval data.

2.10 Field Meters

- .1 Shall be able to measure demand (KW), consumption (KWh), and usage (cubic meters, cubic feet, BTU's, etc.).
- .2 Shall be equipped with a pulse output and visual read out.
- .3 Power supply requirements: *Self-powered*
- .4 Shall be suitable for flow rate, pressure and temperature, and pipe size required for the mechanical system operation.
- .5 Accuracy: +/- 0.5% of 100% registration at 1.0 p.f., 1% to 100% load. It shall meet Measurement Canada accuracy requirements.
- .6 Operating Temperature: -40 deg. C to +55 deg. C
- .7 Electrical Meters
 - .1 Electrical meters shall be provided by Division 26.
 - .2 Voltage rating: 347/600V 3ph 4w or 600v 3ph 3w
 - .3 Operating frequency: 60 Hz
 - .4 Power factor range: 0.5 to 1.0 lead/lag

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- .5 Electrical meters shall be revenue grade (1% accurate) but do not need to be sealed for the purposes of M&V.
- .6 Communications cable from meters to DMS computer location shall be provided by Division 26.
- .7 All electrical meters, including the main incoming service meters, shall be inter connected by a network connected to the DMS computer.
- .8 Provide interface equipment as required to connect the electrical meters to the DMS computer.
- .8 Gas, BTU and Water Meters
 - .1 Gas, BTU and water meters shall be provided by Mechanical Contractor.
 - .2 Gas, BTU and water meters shall be revenue grade (1% accurate) but do not need to be sealed for the purposes of M&V.
 - .3 Communications cable from meters to DMS computer location shall be provided by Electrical Contractor.
 - .4 All gas, BTU and water meters, including the main incoming service meters, shall be inter connected by a network connected to the DMS computer.
 - .5 Provide interface equipment as required to connect the gas, BTU and water meters to the DMS computer.

2.11 Acceptable Manufacturers

- .1 CARMA CORP.
- .2 Schneider Powerlogic
- .3 Power Measurement ION
- .4 Triacta/Schneider PowerHawk
- .5 Approved Alternate

2.12 List of Field Meters

- .1 Provide Project Specific Meter List and Metering Requirements
 - .1 Electricity: Voltages, Currents, 3ph/3w or 3ph/4w

2.13 System Architecture

- .1 See Appendix A.

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PART 3 - EXECUTION

3.1 Installation

- .1 The installation of the metering equipment shall be performed by licensed electricians, under the direct supervision of factory trained personnel.
- .2 Install meters as indicated on drawings/tender documents.
- .3 Division 23 is responsible for installing gas, BTU and water check meters capable of integration into the DMS network and equipped with visual read out.
- .4 Electrical Contractor is responsible for providing a connection (including all the rough-ins, ie. Conduits, wiring, etc.) from the gas, BTU and water check meters to the digital metering system location.
- .5 Division 26 is responsible for installing electric meters capable of integration into the DMS network.
- .6 Division 26 to coordinate with Division 23 for the installation of all the meter interconnections to the DMS. All wiring shall be completed by Division 26 as per specifications. All wiring will be done in accordance with Canadian National Electric Code standards and regulations, and in conjunction with the local Electrical Safety Association office.
- .7 Size and colour code wiring according to manufacturer's recommendations. All wiring shall be CSA approved and rated for 600V for low voltage conditions and 300V for extra low voltage conditions. Communication wiring shall be installed in twisted pairs to prevent interference from outside sources.
- .8 All current transformers will be installed with shorting switches so meters can be removed without high voltage electrical hazard.

3.2 Calibration

- .1 Setup meters according to manufacturer's instructions.
- .2 Commission the system to the satisfaction of the Measurement and Verification consultant and demonstrate the proper functioning of the system.
- .3 Provide a 3 hour training session to the owner's staff and Measurement and Verification consultant.
- .4 Provide Measurement & Verification consultant with remote access to the system.
- .5 Typical system architecture: The typical system architecture for a DMS is included in Appendix A for reference purposes.

3.3 Warranty

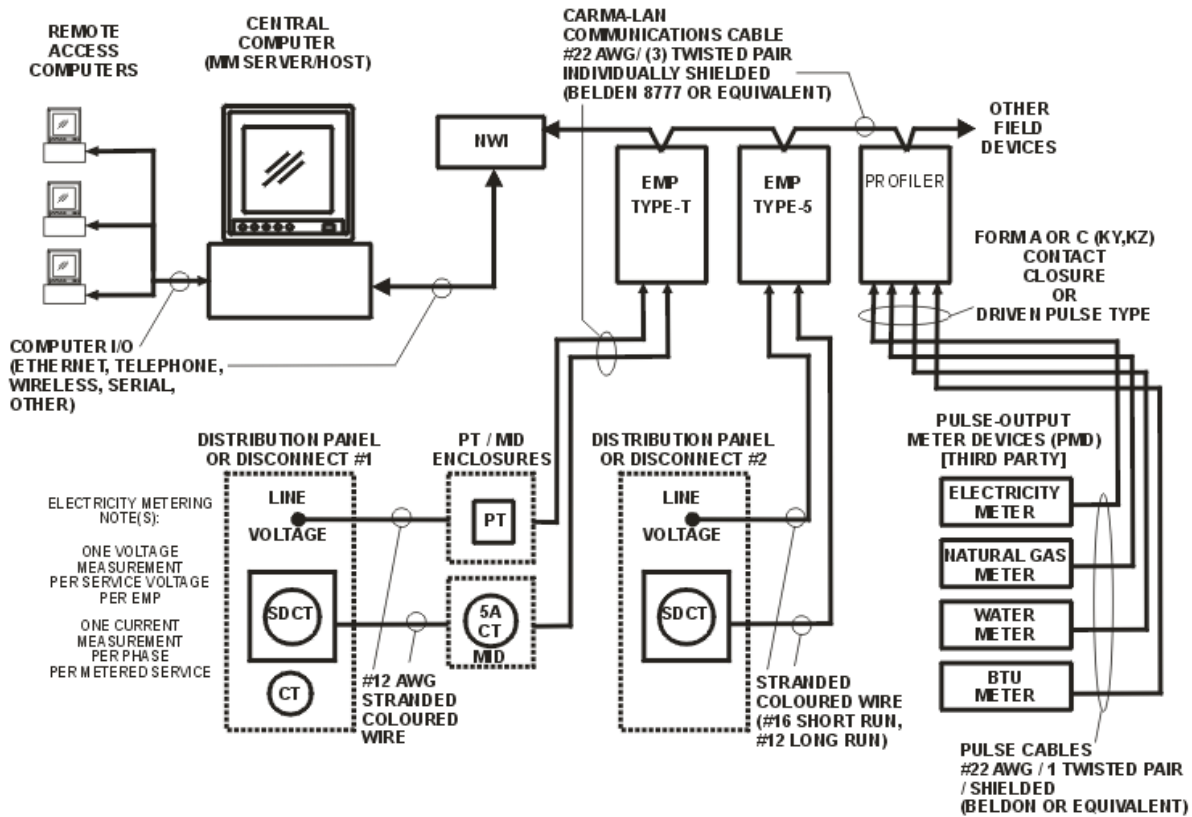
- .1 All equipment shall be free from defect in materials and workmanship under normal use and service for the period of twelve (12) months from the date of substantial completion.
- .2 All equipment will be verified by a factory-trained technician and certified for its Revenue Class accuracy.

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- .3 A certificate shall be issued on final completion to confirm that the system is operating according to specifications.

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260902 - APPENDIX A: SYSTEM ARCHITECTURE



Terms	
NWI	• NETWORK INTERFACE (COMMUNICATIONS METHOD CHANGES)
EMP	• ENERGY MONITORING POD
PROFILER	• PULSE TOTALIZING PANEL
PT	• POTENTIAL TRANSFORMER (120V, 347V, 600V OR OTHER)
CT	• CURRENT TRANSDUCER (100A, 200A, 400A)
MID	• METER INTERFACE DEVICE (5A CT'S)
SDCT	• 5AMP STEP-DOWN CURRENT TRANSFORMER
	• (SERVICES >400A OR CRITICAL LOADS)

NOTES:

- Schematic diagram indicates the typical components that make up a particular Meter Manager™ Submetering System installation.
- PTs and CTs measure voltage and current (respectively), allowing EMP's to calculate electricity consumption. For services over 400A, or critical loads, Measurement Canada Approved SDCTs (Current/Instrument Transformers) are installed on the service and connected to a MID (5 or 10 AMP CTs)
- Third Party Electricity, Natural Gas, Water and BTU (heating energy) meters are integrated into the system by Profiler Panels through pulse outputs.
- Central System (HOST computer/DCU) collects data/meter readings from the EMP's and Profilers on the CARMA-LAN. This can be either onsite or at a remote location.
- Remote access to the system can be made through a vast number of methods, including: Ethernet (WAN /Internet/VPN), telephone line and more.

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260902 - APPENDIX B: SAMPLE M & V OUTPUT FILE FOR ELECTRICAL METERING

Date / Time	KWh	KW	kVA
8/29/2008 1:00	14027.17	7.5	0.3
8/29/2008 1:15	14025.2	8.1	0.8
8/29/2008 1:30	14023.2	7.3	1.0
8/29/2008 1:45	14021.4	5.3	1.0
8/29/2008 2:00	14020.0	3.5	1.0
8/29/2008 2:15	14019.1	2.4	0.9
8/29/2008 2:30	14018.5	1.9	0.8

END OF SECTION

Wiring Devices

PART 1 - GENERAL

1.1 General Requirements

- .1 The General Conditions of CCDC 2 and the General Requirements of Division 1, form part of this section, and must be read in conjunction with the requirements of this section, and all related sections.
- .2 Provide all switches, receptacles, wiring devices, cover plates as required to complete the installation.

1.2 References

- .1 Comply with the requirements of the latest editions of the following:
 - .1 CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Wiring Devices.
 - .2 CSA-C22.2 No.42.1, Cover Plates for Flush-Mounted Wiring Devices.
 - .3 CSA-C22.2 No.55, Special Use Switches.
 - .4 CSA-C22.2 No.111, General-Use Snap Switches.
 - .5 CSA-C22.2 No. 144, Ground Fault Circuit Interrupters.

1.3 Submittals

- .1 Submit Shop Drawings and Product data in accordance with Section 260100 – Electrical General Requirements.
- .2 For Occupancy & Daylighting Sensors, submit a lighting plan clearly marked by manufacturer showing proper Product, location and orientation of each sensor. This plan shall reviewed by Consultant prior to manufacturing.

1.4 Manufacturer

- .1 Wiring devices shall be manufactured by 1) Hubbell; 2) Pass & Seymour; 3) Bryant; 4) Approved Equal. Catalogue numbers are referred below to indicate quality standard.

PART 2 - PRODUCTS

2.1 Switches

- .1 Switches shall be with following features:
 - .1 White premium specification grade, quiet type.
 - .2 Terminal holes approved for No. 10 AWG wire.

Wiring Devices

- .3 Silver alloy contacts.
- .4 Urea or melamine moulding for parts subject to carbon tracking.
- .5 Suitable for back and side wiring.
- .6 Fully rated for tungsten filament and fluorescent lamps.
- .2 Switches for 120 Volt lighting circuits
 - .1 Hubbell CSB115W, CSB315W and CSB415W, 15 ampere for single pole, three-way and four-way switching as required for the application. Equivalent Series of 347V light switches shall be provided for 347V circuits.
- .3 Switches for 347 Volt lighting circuits
 - .1 Hubbell HBL18221, HBL18223, 20 ampere for single pole, three-way switching as required for the application. Switch handles – white. Provide key operated switches where shown of the same series.
- .4 Switches for motor or other control applications shall be horsepower rated, Hubbell, HBL7832D and HBL7810D 30Ampere for double-pole and three-pole for one application.

2.2 Receptacles

- .1 Receptacles shall be with following features:
 - .1 White premium specification grade, urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Break off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and riveted grounding contacts.
 - .6 Impact-resistant nylon face.
 - .7 U-ground.
 - .8 GFCI receptacles shall meet UL 943 requirements and be complete with self test and reset buttons, and LED indication light.
- .2 Duplex receptacle, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, BR15WHI (CSA 5-15R).
- .3 Duplex receptacle, 20 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, BR20WHI (CSA 5-20RA).
- .4 GFCI duplex receptacle, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, GFST15W (CSA 5-15R).
- .5 GFCI duplex receptacle, 20 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, GF20STW (CSA 5-20RA).
- .6 Single 30 amp, 120 volt, 1 phases, 2 pole, 3 wire, Hubbell, HBL9308 (CSA 5-30R).

Wiring Devices

- .7 Single 30 amp, 120/208 volt, 2 phases, 3 pole, 4 wire, Hubbell, HBL9430A (CSA 14-30R).
- .8 Single 50 amp, 120/208 volt and 120/240 volt, 2 phases, 3 pole, 4 wire, Hubbell, HBL9450A (CSA 14-50R).
- .9 TVSS duplex receptacle, Gray, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, HBL5262GYWSA (CSA5-15R).
- .10 Tamper-resistant duplex receptacle, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, BR15WHITR (CSA5-15R).
- .11 Weather-resistant duplex receptacle, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, BR15WHIWR (CSA5-15R).

2.3 Cover Plates

- .1 Stainless steel type 302, complete with matching screw, for all wiring devices.
- .2 Weatherproof covers shall be while-in-use type polycarbonate body, cover and plates, conform to NEMA3R. Hubbell # WP826MP.
- .3 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .4 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.
- .5 Water-tight hinged cover suitable for floor box for ganged receptacles, data/telephone outlets, finish to Consultant's directions.

PART 3 - EXECUTION

3.1 General

- .1 Install single throw switches with handle in "UP" position when switch closed.
- .2 Install devices in gang type outlet box when more than one switch is required in one location. When supplied from different voltages or power sources, provide metal barriers in the ganged box.
- .3 Clean debris from outlet boxes.
- .4 Install devices plumb and level.
- .5 Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.
- .6 Adjust devices and wall plates to be flush and level.
- .7 Clean exposed surfaces to remove splatters and restore finish.
- .8 Test each receptacle device for proper polarity.
- .9 Test each GFCI receptacle device for proper operation.

Wiring Devices

- .10 Contractor shall ensure that all occupancy sensors are located, installed, and adjusted as intended by the factory and the Contract Documents.
- .11 Contractor shall ensure that the occupancy sensors are operating within the manufacturers specifications.
- .12 Contractor shall verify with Occupancy Sensors Manufacturer/Supplier proper locations of occupancy sensor for better coverage prior to rough-in and shall comply accordingly.

END OF SECTION

Surge Protective Devices

PART 1 - GENERAL**1.1 General**

- .1 The General Conditions of CCDC-2 Division 1, form part of this section, and must be read in conjunction with the requirements of this section, and all related sections.
- .2 The work of this section, and related work specified in other sections shall comply with all requirements of Division 1 – General Requirements.
- .3 Conform to the conditions stated in the Contract Form and Supplementary Conditions.
- .4 This section of the Specification is an integral part of the Contract Documents and shall be read accordingly. This Section applies to and is a part of all Sections of Divisions 26.

1.2 Summary

- .1 The Specifications in this section describe the electrical and mechanical requirements for a protection system provided by high-energy transient voltage surge suppressors. The specified system shall provide effective, high-energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B and C environments (as tested by ANSI/IEEE C62).

1.3 Standards

- .1 The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:
 - .1 Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, C62.45)
 - .2 American National Standards Institute
 - .3 Federal Information Processing Standards Publication 94 (FIPS PUB 94)
 - .4 National Electrical Manufacturer Association (NEMA LS-1 1992 Peak Current Testing)
 - .5 National Fire Protection Association (NFPA 70, 75 and 780)
 - .6 MIL Standard 220A Method of Insertion Loss Measurement
 - .7 Canadian Electric Code
 - .8 Underwriters Laboratories UL 1283 and UL 1449 (3rd Edition)
 - .9 Canadian Standards (CUL)

Surge Protective Devices

1.4 Environmental Requirements

- .1 The operating temperature range shall be -40° to 70° C (-40° to 160° F).
- .2 The unit shall be capable of operation up to 13,000 feet above sea level.
- .3 No appreciable magnetic fields shall be generated. Unit shall be capable of use in computer rooms without danger to data storage systems or devices.

1.5 Manufacturer Qualifications

- .1 Total Protection Solutions, distributed by International Innovative Systems shall be the basis of design. The manufacturer must be regularly engaged in the design, manufacturing and testing of SPD's of the types and ratings required for a period of not less than ten (10) years.
- .2 Acceptable Alternates: Cutler-Hammer, Siemens, Schneider or Approved Equal

PART 2 - PRODUCTS

2.1 Performance

- .1 General
 - .1 The SPD's as installed must be U.L. 1283 and U.L. 1449 Third Edition listed, and not merely the components or modules.
 - .2 The TVSS shall protect all modes L-G, L-N, L-L, and N-G, have discrete suppression circuitry in L-G, L-N and N-G, and have bidirectional, positive and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified, and accordingly reduced mode units with suppression circuitry built into only 4 modes are not acceptable.
 - .3 Obtain all surge suppression devices through a single manufacturer.
 - .4 The maximum continuous operating voltage (MCOV) of all components shall not be less than 125% for a 120V system and 120% for 220 and 240V systems, and 115% for 347 and 600V systems.
 - .5 All SPD's shall be equipped with a comprehensive monitoring system which shall include a visual LCD panel display providing information on unit status and phase loss/protection loss.
 - .6 If a disconnect switch is specified, the disconnect switch and the SPD as a system shall be capable of interrupting up to a 200kA symmetrical fault current with 600 VAC applied.
 - .7 For technical support and ordering information call International Innovative Systems 877-775-7474 or 905-775-7474.

Surge Protective Devices

.2 Service Entrance Protection

- .1 The SPD for this location shall be as indicated on project drawings. SPD shall be separate from panelboard. Integral SPD shall not be acceptable. SPD shall be certified to UL1283 and UL 1449 3rd Edition Type 1 for use in Type1 or Type 2 locations.
- .2 Service entrance panels shall be protected by a Total Protection Solutions panel mounted SPD, model TK-ST160-3Y600-L for 347/600 volt panels.
- .3 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories C1 and C3 bi-wave, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, and UL suppressed voltage ratings, all of which shall be no higher than:

ANSI/IEEE C62.41-1991 Measured Limiting Voltage							
Voltage		B3/C1 Impulse 6 kV, 3 kA		C3 Impulse 20 kV, 10 kA		UL 3 rd Edition VPR	
347/600 (3Y600)	L- N	L-L	1242V	2280V	1710V	2893V	1500V 2500V
	L- G	N-G	1294V	1190V	1783V	1610V	1500V 1500V

- .4 The unit shall have a peak surge current of no less than 160kA/phase, 80kA/mode, 8 X 20 us waveform, single impulse.
- .5 Internal Dual Fusing

.1 Overcurrent Protection

- 1. Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses.

Overcurrent fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more than one MOV per mode.
- 2. For arc quenching capability, minimization of smoke and contaminants in the event of a failure, and to ensure the safest possible design, all surge components, current carrying paths and fusing shall be packed in silica sand.
- 3. Fusing shall be present in every mode, including Neutral-to-Ground.

Surge Protective Devices

4. The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied.
- .2 Sustained over voltage protection
 1. To prevent thermal runaway of MOV's or other suppression components in the event of a sustained overvoltage condition, the suppression components must also be protected by thermal fusing. Thermal fusing is in addition to the above specified overcurrent protection, and internal thermal fusing alone without internal overcurrent fusing is not acceptable.
- .6 The SPD shall come standard with not less than a Thirty Year Warranty, and the warranty shall include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period. Special warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.
- .7 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a Nema 4 steel enclosure.
- .8 The SPD shall have an internal audible alarm with mute on front cover.

PART 3 - EXECUTION

3.1 Installation

- .1 Install the SPD's with the conductors as short and straight as practically possible.
- .2 Follow the SPD manufacturer's recommended installation practice as outlined in the equipment installation manual. The electrical contractor shall ensure that all neutral conductors are bonded to the system ground at the service entrance or the serving isolation transformer prior to installation of the associated SPD.
- .3 The installing contractor shall comply with all applicable codes.

END OF SECTION

Electric Vehicle Charging Station

PART 1 - GENERAL**1.1 Summary**

- .1 This section of specification is an integral part of the contract documents and shall be read accordingly.
- .2 Comply with Section 260100 – Electrical General Requirements.

1.2 Reference

- .1 Comply with all requirements of the latest edition of CSA Standards.

1.3 Submittals

- .1 Submit shop drawings in accordance with Section 260100.

1.4 Definitions

- .1 **Access Card:** a radio frequency identification (RFID) card allowing Users access to a Charging Station. Each Access Card bears a unique identification number and enables a Charging Station to identify that User and the corresponding User Account with the network provided by the EV Charger Service Provider.
- .2 **Active Charging:** An electric or plug-in hybrid vehicle which is connected to and receiving power from an electric vehicle charging station.
- .3 **Charging Station Management System (CSMS):** A network connected software platform that manages EV Charging Station access, collects and stores data, and performs analytics.
- .4 **Data:** Charging station data includes the charging session start time, date, and duration, amount of electricity provided to vehicle, and the amount of revenue collected at a minimum.
- .5 **Distributable Revenues:** Net Revenues minus Transaction Fees and minus Taxes on Transaction Fees (if applicable).
- .6 **Electric Vehicle:** A vehicle that uses one or more electric motors for propulsion. They can be classified as Battery Electric Vehicles (BEVs), which use only electricity, or Plug- in Hybrid Electric Vehicles (PHEVs), which use fossil fuels via an internal combustion engine and electricity via a high capacity battery. Both plug in to recharge.
- .7 **Electric Vehicle Charger Service Provider:** A third-party organization that supplies EV charging stations, remote diagnostics and troubleshooting, maintenance services, a data collection and analytics platform, and/or customer support.
- .8 **Electric Vehicle Charging Station:** Equipment that connects an electric vehicle to a source of electricity to recharge its batteries.

Electric Vehicle Charging Station

- .9 **Greenhouse Gases (GHGs):** Gases that absorb and emit radiant energy within the thermal infrared range. The accumulation of greenhouse gases in the atmosphere cause the greenhouse effect and contribute to planetary warming and climate change.
- .10 **Level 2 charging station:** A charging station which operates at 208 VAC, and typically ranges 7.2 kW of power output. One hour of Level 2 charging at full capacity delivers approximately 30-50 km of vehicle range.
- .11 **Net Revenues:** Gross Revenues minus applicable taxes.
- .12 **Open Charge Point Protocol (OCPP):** is a language for communication between a Charging Station and a Charging Station Management System (CSMS). It is freely available for use by anyone at no cost.
- .13 **Operators/Property Managers:** City of Brampton Departmental or Divisional representative(s) responsible for maintaining the infrastructure and amenities of a building where EV charging stations are installed.
- .14 **Payment Card Industry Data Security Standard:** An information security standard, administered by the Payment Card Industry Security Standards Council, for organizations that handle credit card transactions. PCI standards were created to increase controls around cardholder data to reduce credit card fraud.
- .15 **Program Owner:** City of Brampton staff person(s) who lead the delivery of program related services at a specific municipal property, and are responsible for decision making surrounding the allocation of budget for capital projects and operating expenses.
- .16 **Service-level agreement (SLA):** A contract between a service provider and the City of Brampton that documents what services the provider will furnish and defines the service standards the provider is obligated to meet.

1.5 Relevant Codes and Standards

- .1 All materials, installation methods, and software platforms associated with EV Charging Stations on City of Brampton properties must comply with the following standards, where applicable.
 - Canadian Standards Association (CSA) Standard 22.2 No. 107.1 or equivalent
 - NEPA® 70 Standard for Electrical Safety in the Workplace®
 - NEC ® Article 625 Electric Vehicle Charging System which covers the installation of electric vehicle charging systems
 - UL 2202 - Standard for Electric Vehicle (EV) Charging System Equipment or equivalent
 - UL 2231 – Personnel Protection Systems for Electric vehicles supply circuits or equivalent

Electric Vehicle Charging Station

- UL 2594 – EV Supply Equipment
- UL 991 – Safety-Related Controls Employing Solid-State Devices
- ICES-003 - Interference-Causing Equipment Standard or equivalent
- IEC 61851-1 - EV Supply Equipment
- OCPP 1.6 or newer - Standard for communication between an EV charging station and an EV Charging Station Management System (CSMS)
- All other standards/codes as applicable by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 EV Charging Station Hardware

This section provides the technical specifications and requirements for electric vehicle charging station hardware installed across City of Brampton properties. It is highly preferred by the City of Brampton that selected EV Charging Stations can support operability with multiple Open Charge Point Protocol compliant Charging Station Management Systems.

.1 Level 2 Charging Stations

- 208-240 volt (V) alternating current (AC) with SAE J1772 connector
- Commercial grade and certified for use in Canada nationally recognized certification agency Canadian Standards Association (CSA), Underwriters Laboratories of Canada (uLC) or other certification marks approved by the Technical Standards and Safety Authority (TSSA);
- Enclosure must be rated for outdoor operation and achieve a minimum National Electrical Manufacturers Association (NEMA) 3R certification
- Enable Open Charge Point Protocol (OCPP) - version 1.6 or higher (OCPP Certificate from Open Charge Alliance available upon request)
- Have certified operating temperature range between minus 35 Degree Celsius (0C) and plus 500C;
- Surge protection 6 kV @ 3,000A
- Cable length must be 5.49 meters (18 feet) or longer, and a cable management / retraction system must be an option and is preferred
- Electricity metering accuracy of +/- 3%

Electric Vehicle Charging Station

- Ability to remotely adjust and manage power supply (energy management and power sharing/limiting features (i.e. adjustable operating current (amperage))
- Cellular network enabled / connectivity (4G/LTE or better)
- REID access in accordance with ISO 14443 A/B, ISO 15693, NEC, NEMA interoperability protocol
- Payment card industry (PCI) compliant card reader (if applicable)
- Light Emitting Diode (LED) status indicator
- Display screen with the capability of conveying messages, user instructions, and/or pricing

2.2 EV Charging Service Provider

.1 General

- .1 All EV Charging Stations installed across City of Brampton owned sites are to have network operability through an EV Charging Service Provider. The City of Brampton requires that the EV Charging Station Management System be Open Charge Point Protocol (OCPP) compliant, with the most up to date OCPP versions being favourable. Accordingly, it is highly preferred by the City that the EV Charging Station Management System has the capability, and has been proven through field testing, to work with EV Charging Station hardware from multiple manufacturers.
- .2 This section outlines the City's requirements and preferences for the system used to manage EV Charging Station operations, the functionalities needed to support a satisfactory user experience, the process for collecting, distributing, and reporting on revenue generation, the minimum requirements for remote monitoring and EV Charger troubleshooting, and the ability for the City to procure maintenance and repair services from the EV Charging Service Provider

.2 EV Charging Station Management System

- .1 The following data points are to be ongoingly tracked, stored, and remain accessible to the City of Brampton in .xls or .csv format in perpetuity by the EV Charging Station Management System:
 - EV Charger Identification (ID)
 - EV Charger location
 - Unique customer identifier (a non-personal identifier (e.g. Network user ID))
 - Charging session date

Electric Vehicle Charging Station

- Charging session start time
 - Charging session end time
 - Amount of power provided during charging session (kWh)
 - Amount of revenue generated (CAD)
 - Encountered malfunctions (including issue codes and descriptions, and duration of downtime)
- .2 The EV Charging Station Management System will include a dashboard that communicates and/or displays at a minimum:
- A map showing the number and location of EV charging stations
 - Real-time EV Charger status (e.g. in-use, available, inoperable, charge per use or free type etc.)
 - Cumulative electricity provided to vehicles, revenue generation, and GHG emissions avoidances are preferred
- .3 The EV Charging Station Management System and/or subsidiary reporting features must provide the following analytical functions at a minimum:
- Isolate all data points by the entire EV charging station portfolio, specific site where chargers are installed, charger type (i.e. Level 2 vs. Level 3), and individual charger.
 - Determine the charging utilization ratio, between a specified calendar or time interval, across the EV Charger portfolio, a specific site, or individual EV Charger (e.g. between 8:30am and 4:30pm at a specified office location, determine what percentage of time are chargers in use)
 - Determine the length of time EVs are plugged in but not actively charging across the EV Charger portfolio, a specific site, or individual EV Charger
 - Report on revenue generation between a specified calendar or time interval
 - The ability to report on greenhouse gas (GHG) emissions avoidances is preferred

Electric Vehicle Charging Station

- .4 The EV Charging Station Management System must provide the following management functions at a minimum:
- Set tiered and flexible pricing models for use (e.g. applying a time-based fee for vehicles which are actively charging AND a different rate for vehicles which remain plugged-in after charging has completed)
 - Automatically program and manually adjust maximum power output and power-sharing modes in EV Charging Stations
 - Enable or disable EV Charger operation
 - Adjust messaging that appears on EV Charger displays
 - Automatically notify operations staff and EV Charger Service Provider of charger malfunctions and loss of functionality
 - The ability to integrate EV Charger operation with electric utility demand response programs is preferred
 - The ability to integrate with fleet fuel cards, telematics, and asset management systems is preferred
 - The ability to integrate with on-site energy storage and generation systems (e.g. solar photovoltaics with battery banks) is preferred
- .5 The EV Charging Station Management System must provide the following management functions at a minimum:
- Set tiered and flexible pricing models for use (e.g. applying a time-based fee for vehicles which are actively charging AND a different rate for vehicles which remain plugged-in after charging has completed)
 - Automatically program and manually adjust maximum power output and power-sharing modes in EV Charging Stations
 - Enable or disable EV Charger operation
 - Adjust messaging that appears on EV Charger displays
 - Automatically notify operations staff and EV Charger Service Provider of charger malfunctions and loss of functionality
 - The ability to integrate EV Charger operation with electric utility demand response programs is preferred
 - The ability to integrate with fleet fuel cards, telematics, and asset management systems is preferred
 - The ability to integrate with on-site energy storage and generation systems (e.g. solar photovoltaics with battery banks) is preferred

Electric Vehicle Charging Station

.3 **User Services**

.1 The City of Brampton requires the following functionalities from the EV Charger Service Provider's networking platform to be provided for users of EV charging stations on City of Brampton owned sites:

- Free subscription to the networking platform
- Locating and providing directions to EV Chargers, communicating accessibility (e.g. hours of operation, public or private), and conveying fees for use via an online and mobile application accessible map
- Authorizing access for station use and facilitating payment for use via a mobile application
- Real-time visibility of the vehicle battery's state of charge (only applicable for Level 3), power provided, and fees incurred during a charging session via a mobile application.
- Notifications sent to EV drivers once a vehicle is fully charged, or reached a user determined battery charge level (only applicable for Level 3), via short message service (SMS) or a mobile application

.2 The EV Charger Service Provider will have the option to provide an access card to users that can enable EV Charger use via RFID, without the use of a mobile application

.3 The EV Charger Service Provider will operate a toll-free 24/7 customer support call-center for users who need assistance accessing the EV Charging Stations

.4 **Remote Upgrades, Monitoring and Troubleshooting**

.1 The EV Charger Service Provider will:

- Perform required firmware and software upgrades remotely
- Attempt to resolve any EV Charger issues remotely within four business hours of issue detection
- If the issue cannot be remotely resolved, notify the City of Brampton's designated operator/property manager of the issue

Electric Vehicle Charging Station

.5 Availability of Maintenance and Repair Services

.1 The EV Charger Service Provider will have offerings for the City to enter into service level agreements (SLAs) to carryout preventative maintenance and repair services as needed for City owned EV Charging Stations. It is highly preferred by the City that the EV Charger Service Provider has the ability to maintain and repair EV Charging Station hardware from multiple manufacturers, and can troubleshoot connectivity and communications issues between EV Charging Stations and multiple Charging Station Management Systems. Field serviceability is essential for all EV Charging Stations, including the upgrade of components needed for network connectivity and communications.

.6 Level 2 Commercial Charging Station by Chargepoint Model CT4000 Series (dual port bollard mount). Reter to attached cut sheets (total 11 pages) or more information

.7 Alternates:

.1 Flo

.2 Or approved alternate

PART 3 - EXECUTION

3.1 General

.1 This section outlines installation requirements as they relate to electrical and civil work, and prescribes signage and parking space painting requirements to ensure EV Charging Station locations and terms of use are clearly communicated. All EV Charging Stations and associated equipment, infrastructure, and will be installed in accordance with the equipment manufacturer's installation requirements.

3.2 Electrical

.1 Where a site is undergoing its first installation of EV Charging Stations, the contractor shall lay parallel conduits that terminate into a buried handwell or weatherproof distribution panel to service a number of additional parking spaces in the future, as determined by the City.

- The number of spaces to 'future-proof' for EV Charging Station installations shall be at the discretion of the site's Property Manager, Operator and/or Program Owner, or Project Sponsor in the case of new construction, subject to existing parking and electrical capacity constraints. In the case where no provisions for future EV Chargers are desired, approvals must be obtained through the City's Energy Management Team.
- Conduits must be sized to accommodate the desired number of EV Charging Stations to future-proof for, taking into account the run length, number and gauges of cables.

Electric Vehicle Charging Station

- .2 The contractor will provide all new circuit breakers from the same manufacturer installed on-site, or an equivalent make
- .3 The contractor is responsible for creating and submitting detailed system design drawings and any accompanying documents to the City of Brampton, and other regulatory agencies as needed to obtain permits and approvals. These include, but are not limited to, Hydro One, Alectra Utilities, the Electrical Safety Authority, the Cities of Brampton and Mississauga, and the Town of Caledon.

3.3 Civil

- .1 The location of all utilities and underground services connections are to be performed by the contractor prior to the installation of EV Chargers
- .2 Parking stalls and aisles shall be designed in accordance with local municipal standards
- .3 All curbs, gutters, raised traffic inlands, walkways, piers, foundations, duct works etc. shall be designed and constructed in accordance with Ontario Provincial Standards
- .4 Positive surface drainage shall be ensured to avoid water ponding
- .5 Underground ducts for all power cables required to feed chargers, lights and ancillary equipment may be necessary
- .6 EV Charging Stations shall be mounted on a pedestal on a concrete pad and/or protected with bollards where required.
- .7 All trees in the vicinity of parking should be retained and protected during construction

3.4 Signage and Parking Space Painting

- .1 The contractor shall provide permanent signage, at least one sign for every two dedicated parking spaces, to read ELECTRIC VEHICLE CHARGING ONLY (see Signage Example 1)
- .2 The contractor shall provide permanent signs, one per charging station site, to outline the terms of use
- .3 The contractor shall provide adequate way finding signage to direct EV drivers to the EV Charger site from the parking lot entrance and/or the nearest street, where deemed necessary by the City

Electric Vehicle Charging Station

- .4 The contractor shall provide parking space pictogram and painting (see parking space painting example)

Signage Example:



Parking Space Painting Example



END OF SECTION

CT4000 Level 2 Commercial Charging Station

Specifications and Ordering Information



CT4021

Ordering Information

The order codes below represent specific product configurations. Other product options are available. Please contact ChargePoint Sales for information and order codes.

Specify model number followed by the applicable code(s).

The order code sequence is: **Model-Options**. **Software**, **Services** and **Misc** are ordered as separate line items.

Hardware

Description		Order Code
Model	1830 mm (6 ft) Single Port Bollard Mount	CT4011-GW1
	1830 mm (6 ft) Dual Port Bollard Mount	CT4021-GW1
	1830 mm (6 ft) Single Port Wall Mount	CT4013-GW1
	1830 mm (6 ft) Dual Port Wall Mount	CT4023-GW1
	2440 mm (8 ft) Dual Port Bollard Mount	CT4025-GW1
	2440 mm (8 ft) Dual Port Wall Mount	CT4027-GW1
Included	Integral Modem – North America	-GW1
Misc	Power Management Kit Bollard Concrete Mounting Kit	CT4000-PMGMT
	Bollard Concrete Mounting Kit	CT4001-CCM

*Note: ALLL CT4000 stations include Integral Modem -GW1.

Software & Services

Description	Order Code
ChargePoint Commercial Service Plan	CPCLD-COMMERCIAL- <i>n</i> *
ChargePoint Enterprise Plan	CPCLD-ENTERPRISE- <i>n</i> *
ChargePoint Assure	CT4000-ASSURE <i>n</i> *
Station Activation and Configuration	CPSUPPORT-ACTIVE
ChargePoint Station Installation and Validation	CT4000-INSTALLVALID

Note: All CT4000 stations require a network service plan per port.

*Substitute *n* for desired years (1, 2, 3, 4 or 5 years)

Order Code Examples

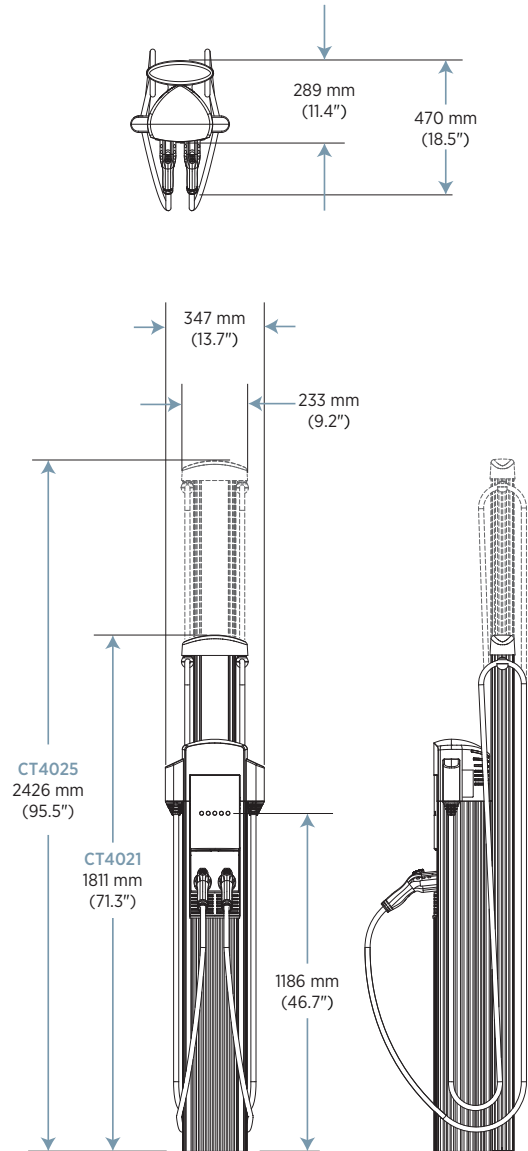
If ordering this...	...the order code is
1830 mm (6 ft) Dual Port Bollard Networked Station with Concrete Mounting Kit	CT4021-GW1 CT4001-CCM
ChargePoint Commercial Service Plan, 3 Year Subscription	CPCLD-COMMERCIAL-3
ChargePoint Station Installation and Validation	CT4000-INSTALLVALID
3 Years of Assure Coverage	CT4000-ASSURE3
1830 mm (6 ft) Single Port Wall Mount Networked Station	CT4013-GW1
ChargePoint Commercial Service Plan, 5 Year Subscription	CPCLD-COMMERCIAL-5
5 Years of Assure Coverage	CT4000-ASSURE5
Station Activation and Configuration	CPSUPPORT-ACTIVE

Architectural Drawings (Dimensions)

CT4021 1830 mm (6')

CT4025 2440 mm (8')

Bollard



General Specifications

Electrical Input

Electrical Input	Single Port (AC Voltage 208 / 240V AC)			Dual Port (AC Voltage 208 / 240V AC)		
	Input Current	Input Power Connection	Required Service Panel Breaker	Input Current	Input Power Connection	Required Service Panel Breaker
Standard	30A	One 40A branch circuit	40A dual pole (non-GFCI type)	30A x 2	Two independent 40A branch circuits	40A dual pole (non-GFCI type) x 2
Standard Power Share	n/a	n/a	n/a	32A	One 40A branch circuit	40A dual pole (non-GFCI type)
Power Select 24A	24A	One 30A branch circuit	30A dual pole (non-GFCI type)	24A x 2	Two independent 30A branch circuits	30A dual pole (non-GFCI type) x 2
Power Select 24A Power Share	n/a	n/a	n/a	24A	One 30A branch circuit	30A dual pole (non-GFCI type)
Power Select 16A	16A	One 20A branch circuit	20A dual pole (non-GFCI type)	16A x 2	Two independent 20A branch circuits	20A dual pole (non-GFCI type)
Power Select 16A Power Share	n/a	n/a	n/a	16A	One 20A branch circuit	20A dual pole (non-GFCI type)
Service Panel GFCI	Do not provide external GFCI as it may conflict with internal GFCI (CCID)					
Wiring – Standard	3-wire (L1, L2, Earth)			5-wire (L1, L1, L2, L2, Earth)		
Wiring – Power Share	n/a			3-wire (L1, L2, Earth)		
Station Power	8 W typical (standby), 15 W maximum (operation)					



Electrical Output

Electrical Output	Single Port (AC Voltage 208 / 240V AC)	Dual Port (AC Voltage 208 / 240V AC)
Standard	7.2 kW (240V AC @ 30A)	7.2 kW (240V AC @ 30A) x 2
Standard Power Share	n/a	7.2 kW (240V AC @ 30A) x 1 or 3.8 kW (240V AC @ 16A) x 2



Power Select 24A	5.8 kW (240V AC @ 24A)	5.8 kW (240V AC @ 24A) x 2
Power Select 24A Power Share	n/a	5.8 kW (240V AC @ 24A) x 1 Or 2.9 kW (240V AC @ 12A) x 2
Power Select 16A	3.8 kW (240V AC @ 16A)	3.8 kW (240V AC @ 16A) x 2
Power Select 16A Power Share	n/a	3.8 kW (240V AC @ 16A) x 1 Or 1.9 kW (240V AC @ 8A) x 2

Functional Interfaces

	Single Port (AC Voltage 208 / 240V AC)	Dual Port (AC Voltage 208 / 240V AC)
Connector Types	SAE J1772™	SAE J1772™ x 2
Cable Length — 1.8 m (6 ft) Cable Management	5.5 m (18 ft)	5.5 m (18 ft) x 2
Cable Length — 2.4 m (8 ft) Cable Management	n/a	7 m (23 ft)
Overhead Cable Management System	Yes	
LCD Display	145 mm (5.7 in) full color, 640 x 480, 30 fps full motion video, active matrix, UV protected	
Card Reader	ISO 15693, ISO 14443, NFC	
Locking Holster	Yes	Yes x 2

Safety and Connectivity Features

Ground Fault Detection	20 mA CCID with auto retry
Open Safety Ground Detection	Continuously monitors presence of safety (green wire) ground connection
Plug-Out Detection	Power terminated per SAE J1772™ specifications
Power Measurement Accuracy	+/- 2% from 2% to full scale (30A)
Power Report/Store Interval	15 minute, aligned to hour. Vehicle to grid connected and responsive to TOU signals
Local Area Network	2.4 GHz WiFi (802.11 b/g/n)
Wide Area Network	LTE Category 4

Safety and Operational Ratings

Station Enclosure Rating	Type 3R per UL 50E
Safety and Compliance	UL and cUL listed; complies with UL 2594, UL 2231-1, UL 2231-2, and NEC Article 625
Station Surge Protection	6 kV @ 3,000A. In geographic areas subject to frequent thunder storms, supplemental surge protection at the service panel is recommended.
EMC Compliance	FCC Part 15 Class A
Operating Temperature	-40°C to 50°C (-40°F to 122°F)
Non-Operating Temperature	-40°C to 60°C (-40°F to 140°F)
Terminal Block Temperature Rating	105°C (221°F)
Operating Humidity	Up to 85% @ 50°C (122°F) non-condensing
Non-Operating Humidity	Up to 95% @ 50°C (122°F) non-condensing
Network	All stations include integral LTE modem and will be automatically configured to operate as gateway or non-gateway as needed

ChargePoint, Inc. reserves the right to alter product offerings and specifications at any time without notice, and is not responsible for typographical or graphical errors that may appear in this document



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Listed by Underwriters Laboratories Inc.



CT4000 Family

ChargePoint® Level 2 Commercial Charging Stations

The CT4000 family is the latest generation of ChargePoint commercial charging stations. Refined yet rugged, these stations set the industry standard for functionality and aesthetics.

The CT4000 full motion color LCD display instructs drivers and supports dynamic updates of custom branded videos and advertisements.

Intelligent power management options double the number of parking spaces served by allowing two charging ports to share a single circuit. Sites with single port EV stations can upgrade to dual port stations without requiring additional electrical services.

The CT4000 is the first ENERGY STAR® certified EV charger because it charges efficiently and conserves power when not charging. As an ENERGY STAR certified EV charger, the CT4000 uses significantly less energy than a standard EV charger when in standby mode to help you save money on your utility bill.

All CT4000 models offer one or two standard SAE J1772™ Level 2 charging ports with locking holsters, each port supplying up to 7.2kW. With this standard connector, ChargePoint level 2 stations can charge any EV.

Stations are available in bollard and wall mount configurations for easy installation anywhere. All stations are fully software upgradeable remotely over the air.

Stations come in both 6' and 8' tall models with 18' and 23' cords, respectively. With multiple options for size and cord reach, your station can service up to four parking spaces, reach all car models regardless of parking style or car sizes and increase the usability of your EV spots.

Driver Friendly User Interface

- + Instructional video shows how to use the station
- + Multi-language: English, French, Spanish
- + Touch button interface; works in rain, ice and with gloves
- + Backed by ChargePoint's world class 24/7 driver phone support

Easily Communicate with Your Drivers

Whether you're a retail establishment wanting to advertise your latest product, a workplace looking to communicate with employees or a municipality wanting to welcome visitors, ChargePoint's prominent LCD screen makes it easy to reach EV drivers:

- + Daylight readable, with auto brightness control
- + 640 X 480 resolution active matrix
- + Full motion 30fps video support
- + Upload up to 60 seconds of high quality video on a color LCD screen to individual stations as often as desired
- + Brand your charging stations to communicate with drivers
- + Instructional video in English, Spanish or French



The First
ENERGY STAR®
Certified EV Charger

Service Products and Support

ChargePoint offers world-class service products and support that help ensure quality of work, save time and money, protect your investment and enhance the productivity of your charging stations. From site planning to installation and setup, to ongoing care and management, when you choose ChargePoint, you're covered.

- + **ChargePoint Configuration and Activation:** customized setup and activation of your stations
- + **ChargePoint Assure:** the most comprehensive EV Station maintenance and management in the industry

Energy Measurement and Management

- + Real-time energy measurement
- + 15 minute interval recording
- + Time of Day (TOD) pricing
- + Load shed by percentage of running average or to fixed power output

Minimize Costs with Flexible Power Management Options

In the vast majority of applications, a full power configuration is the best choice for both station owners and drivers. However, when drivers are parked for a longer time, an intelligent, lower power output can save station owners considerable installation cost while still providing drivers a great charging experience. With flexible power options, station owners can meet the needs of drivers while lowering costs:

Power Select (Patent Pending)

- + Allows for a lower capacity (less than 40A) circuit to power each port
- + Cuts installation costs by reducing the cost or even avoiding the need to upgrade panels or transformers

Power Sharing

- + Dynamically share one 40A, 30A or 20A circuit between two parking spaces
- + Doubles the number of parking spots served while reducing installation and operating costs
- + Allows station owners to upgrade a single port station to dual port to serve more drivers with no electrical upgrade

Clean Cord Technology

- + Keep charging cords off the ground
- + Standard on all models
- + Ultra-reliable second-generation gravity operated mechanism
- + Flexible over entire -40°F to +122°F product temperature range

Safe, Reliable, Energy Efficient Hardware

- + UL listed, meeting the stringent requirements of the nation's leading safety standards organization
- + Stations are rugged, built to withstand the elements
- + Safe, Reliable and Energy Efficient
- + ENERGY STAR certified, charges efficiently and conserves power when not charging

When Charging is Mission Critical, Protect Your Investment with ChargePoint Assure

- + **Minimize downtime:** ChargePoint Assure provides the most comprehensive EV Station maintenance and management in the industry
- + **Get up and running quickly and flawlessly:** Professional guidance for station configuration saves you time, and unlimited changes to station policies flexibly supports your business
- + **Eliminate unexpected future expenses:** Cost for parts and on-site labor to install is covered for all Assure eligible repairs
- + **One less thing to worry about:** Proactive station monitoring provides you with regular reporting
- + **Reduced risk of downtime:** We guarantee 98% annual uptime and one business day response to requests
- + **Support when you need it:** We're there for you *and* your drivers. Phone support available for station owners Monday to Friday from 5 AM to 6 PM Pacific. Phone support for drivers is 24/7/365, so you never need to field a driver call

Ultra-reliable second-generation gravity operated mechanism.

18' and 23' cords to reach all car models and serve more parking spaces.

World-class 24/7 driver phone support.

Instructional video shows how to use the station. Multi-language charging instructions, giving drivers the choice of English, French or Spanish.

Driver interaction is supported in any weather by five rugged, back-lit buttons with audio feedback.

Strong and rugged design materials built to withstand the elements.

CT4000 stations come with 18' or 23' cords to increase the usability of your charging spots, on 6' and 8' tall models respectively.

CT4021

Dual-port bollard charging station with 18' charging cables. Standard *EV Charging Only* sign without optional custom branding.



Promote Your Brand and Business

Having your stations installed in a visible location makes a bold statement about your business' commitment to sustainability and shows that you care about your customers. ChargePoint CT4000 stations are built for customization so you can conveniently promote your brand as well. With custom signage and video you can:

- + Increase brand recognition
- + Attract EV drivers by making sure your stations are highly visible
- + Ensure EV charging installations are consistent with the look and feel of your brand
- + Differentiate your stations from standard ChargePoint stations to make them easily identifiable by your driver base



Branded CT4021
Shown with optional
branding on bollard.
18' cords on 6' model.

Easily customizable branding area.
All stations come with *EV Charging Only* sign, which can be replaced with your custom signage.

5.7" color LCD display for customizable video content.

Upload up to 60 seconds of high quality video to individual stations as often as desired.

Daylight readable with auto brightness control.

OPTIONAL:
Additional customizable branding areas.

All stations have standard extrusions to hold your custom signage.

Artwork templates and material specifications are conveniently downloadable from chargepoint.com



Branded CT4025
Shown with optional
branding on back.
23' cords on 8' model.

Bollard Charging Stations

CT4011



CT4021



CT4025



Wall Mount Charging Stations

CT4013






CT4023



CT4027



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Service

PART 1 - GENERAL

1.1 General Requirements

- .1 The General Conditions of CCDC 2 and the General Requirements of Division 1, form part of this section, and must be read in conjunction with the requirements of this section, and all related sections.

1.2 Scope

- .1 Hydro connection/service fee will be paid by Cash Allowance.
- .2 Provide Hydro service as required and to Hydro requirements.
- .3 Electrical contractor to include fees for all inspection and/or testing as required by Electrical Safety Authority.
- .4 Primary and secondary duct banks as indicated on Drawings.
- .5 Warning signs shall be fastened to each piece of apparatus as may be required by Hydro and Electrical Safety Authority.
- .6 Transfer foundation, pad, grounding and protection bollards.
- .7 Obtain the approval from Hydro and the Electrical Safety Authority on complete service.
- .8 Retain a testing company to carry out testing and checking perform co-ordination study and arc flash protection study as listed herein. Provide correction and maintenance on the system to direction of the testing and checking results.

1.3 Submittals

- .1 Submit all required documentation to ESA for approval.
- .2 Submit the co-ordination study for review to:
 - .1 Consultant.
 - .2 Inspection Authority, if required.
- .3 Following completion of all inspection, testing and commissioning, submit a report prepared by the testing company to include but not limited to:
 - .1 All results recorded and referenced to the various sections of the electrical systems.
 - .2 Comments and recommendations where variations occur to the co-ordination study or accepted testing and performance values.
 - .3 Thermal photography where abnormal heating conditions are indicated and repeated photographs following correction.

Service

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION**3.1 System Coordination and Short Circuit Study**

- .1 Retain the services of an approved testing company to perform protective co-ordination study to establish optimum settings and selections for all protective devices. Provide system coordination study and short circuit study for HV switchgears and cables, power transformer, LV switchgears/panels and cables.
- .2 The study shall illustrate:
 - .1 Study single line diagrams, showing steady-state and transient values.
 - .2 Three phase bolted fault current, symmetrical and asymmetrical, and minimal arcing ground fault values.
 - .3 Time-current characteristic curves of all pertinent relays, breakers, fuses, etc.
 - .4 Thermal damage curves for cable, transformers, motors and the like.
 - .5 Summation chart showing all ratings and settings referenced to the appropriate time-current characteristic curve.
- .3 Provide all circuit breakers and protective devices with relays, trip settings, frame sizes and short circuit withstand ratings as determined from the co-ordination study.
- .4 Acceptable testing companies:
 - .1 Brosz and Associates
 - .2 G.T. Woods
 - .3 Cutler-Hammer
 - .4 Schneider
 - .5 Siemens
 - .6 Approved Equal

3.2 Arc Flash Protection

- .1 Retain the services of an approved testing company to perform arc flash hazard study and calculation for all switchboards, panel boards, transformer, panels, control panels, MCC, meters, disconnect switches, breakers, etc, that require examination, adjustment, servicing, or maintenance while energized.
- .2 The study and calculation shall meet IEEE 1584-2002, Guide for Performing Arc-Flash Hazard Calculations.

Service

- .3 Provide arc flash report to include the following, but not limited to:
 - .1 Results of the study and calculation.
 - .2 Detailed hazard/risk category (0 to 5).
 - .3 Voltage shock hazard, incident current and energy.
 - .4 Flash protection boundary and shock approach boundaries.
 - .5 The protection plan including safe work procedures, preventive maintenance programs, personal protective equipment, etc. The protection plan shall meet CSA Z462-08, workplace electrical safety.
- .4 Based on the arc flash report, provide required labels state the existence of arc flash hazard and the corrective action to take. The labels must meet ANSI Z535.4-2002, product Safety signs and Labels.
- .5 Provide coordination/short circuit/Arc flash study/shop drawings for Engineer's review and comments before manufacturing of electrical panelboards.

3.3 Inspection and Test

- .1 Systems, equipment and all major items of material shall be tested to the satisfaction of the Consultant, and as required to establish compliance with plans and specifications, and with the requirements for the Supply and Inspection Authorities.
- .2 Faulty and defective equipment shall be replaced with new materials Conductors which are found to be shorted or grounded, or to have less than proper insulation resistance, shall be replaced with new conductors.
- .3 Tests shall include but are not limited to the following:
 - .1 Test of power cables shall include megger tests to establish proper insulation resistance, and phase-to-ground resistance of cables.
 - .2 Test of all adjustable electrical protective devices of switchgear to establish calibration and operation in accordance with specifications and approved co-ordination curves. Insulation tests and torque tests. High potential tests where recommended by manufacturer.
 - .3 Visual examination of switchgear to determine adherence to allowable manufacturing tolerance and compliance with manufacturer's recommended installation requirements.
 - .4 Proper functioning of all systems.
 - .5 Polarity tests - to establish proper polarity connections to all sockets and receptacles.
 - .6 Calibration setting, and test-tripping, of all protective relays and devices, using "Primary-injection" equipment, in accordance with approved co-ordination schedule.

Service

- .7 Test of all alarm devices and contacts. The Contractor shall cooperate with Inspection personnel, open all equipment enclosures to permit inspection, and make good defective conditions.
- .8 Inspection after system is energized shall include infrared thermographic examination of current carrying parts in switchgear, transformers, and at ducts. The Contractor shall cooperate with Inspection personnel, open all equipment enclosures to permit inspection, and make good defective conditions.
- .9 Testing Company
 - .1 Retain the services of an independent testing company, to Engineer's approval to perform the above tests.
 - .2 The testing company shall submit test results directly to the Consultant.
 - .3 Include copy of tests in Maintenance and Operating Manual.
- .4 Certification of Tests
 - .1 When work is complete, submit three copies of test results and a signed statement listing all tests that have been performed as required by specifications and manufacturer's instructions.

3.4 Primary and Secondary Duct Banks

- .1 Provide underground primary and secondary duct banks as detailed on Drawings to pad mount transformer terminating as directed on site and to the electrical room, to provide for installation of primary and secondary cables. Construction details and exact location of terminations shall be verified on the site prior to installation commencing.
- .2 Provide duct bank constructed to ESA and Supply Authority's approval comprising PVC Class 1 CSA approved ducts with minimum internal diameter of 104 mm (4 inches), buried to a depth to provide 760 mm (30") minimum cover over the duct run. Ducts shall be laid parallel, spaced 152 mm (6") on centre horizontally and vertically, encased throughout their length in concrete, with a minimum cover of 76 mm (3") on all sides. The duct shall be on even grade, sloped not less than 76 mm (3") in 30 mm (100 feet), and drained in accordance with Hydro regulations. All ducts shall be sealed with pipe caps during construction. The duct bank enclosure shall be steel reinforced as detailed. Provide Bell ends for all ducts.
- .3 Provide in each duct a 5/16" (8 mm) polypropylene Draw Rope, to facilitate the cable installation.
- .4 The ducts shall be encased in a concrete envelope which shall be worked below and between ducts to provide a homogenous mass. Duct spacers shall be plastic to provide required spacing both horizontally and vertically. Minimum of two spacers per 3050 mm (10 ft.) length of duct shall be used. Ducts shall terminate to approval of Supply Authority. Provide warning tape along the entire length of duct banks.

Service

- .5 The following inspections of the primary ducts shall be witnessed by the Supply Authority and Inspection Authority. Notify Supply Authority prior to requested date of inspection.
 - .1 The complete run shall be inspected before the concrete encasement is placed.
 - .2 The duct run shall be `proved' clear by pulling a 95 mm (3-3/4") mandrel wire brush and cleaning swabs through their complete length.
 - .3 For Primary Ductbank, provide 150mm wide polyethylene red warning tape with the message "Caution – High Voltage Electric Line Buried Below" at 457mm below finished grade continuously along the length of all trenches. Confirm this requirement with Supply Authority and ESA prior to proceeding.
- .6 For Secondary Duct Banks, provide warning tape as required by latest OESC Code and Bulletins.

3.5 Transformer Foundation, Grounding and Bollards

- .1 Provide a precast concrete foundation for installation of the padmount transformer in accordance with Supply Authority Standards.
- .2 Provide a grounding system at the transformer foundation in accordance with Supply Authority's Standards. Provide #2/0 AWG copper conductor connected to building ground system.
- .3 All work in connection with the primary and secondary ducts and transformer foundation shall be performed in strict accordance with regulations and the Supply Authority's details and requirements. Obtain approval of all details before commencing work. Refer to Item 3.5 for more information.
- .4 Provide concrete bollards in accordance with Supply Authority standards.

3.6 Electrical Service

- .1 Provide complete electrical service as shown on the Drawings and as further described here.
- .2 The Supply Authority will supply electrical service at 600 volt, 3 phase, 4 wire, 60 cycles.
- .3 Grounding service, equipment, feeders, and the like shall be performed in accordance with Hydro regulations and the Supply Authority's requirements.
- .4 The neutral conductor of the wiring system together with the conduit system and service equipment shall be bonded to the water service as near as practical to the service entrance.
- .5 Provide an "Artificial Grounding" system in accordance with Canadian Electric Code, Section 10-702 and Ontario Hydro Supplement. Location shall be to approval of the Supply & Inspection Authority requirements.

Service

- .6 Provide indoor meter enclosure (10"D x 20"W x 30"H) and coordinate on site for enclosure location, all to approval of Supply Authority, connected to switchboard with an empty 38 mm 1-1/2" rigid conduit.
- .7 Provide 19mm conduit for dedicated telephone line from telephone demarcation point to metering cabinet.

3.7 Secondary Cables

- .1 Secondary cables shall be supplied and installed including secondary connections by Division 26.

END OF SECTION

Grounding

PART 1 - GENERAL

1.1 General Requirements

- .1 The General Conditions of CCDC 2 and the General Requirements of Division 1, form part of this section, and must be read in conjunction with the requirements of this section, and all related sections.
- .2 Provide all grounding to comply with the Ontario Electrical Safety Code and the latest instructions of the Inspection Authority, with any further requirements as noted herein.

PART 2 - PRODUCTS

1.2 MATERIALS

- .1 All grounding conductors stranded copper, bare or insulated as required.
- .2 All grounding conductors stranded copper, bare or insulated as required.
- .3 Use Cadweld process for all weld connections. Burndy and/or AMP of Canada Ltd. mechanical grounding connectors are an acceptable equivalent to welded connections.
- .4 All ground connectors to be designed and approved for grounding purposes.
- .5 Ground conductors – copper conductor in conduit sized to meet electrical safety requirements unless otherwise noted.

PART 3 - EXECUTION

1.3 Installation

- .1 Provide ground busses in the main electrical room for use in bonding equipment in the room. Ground the buses per Electrical Safety Code. Provide ground connections from buses to main low voltage switchboards and all exposed metal work. Provide ground connections to the main water supply pipe.
- .2 Connect the ground bus inside the switchgear assembly to the grounding system.
- .3 Inside main secondary switchboard, connect the neutral bus to the ground bus with conductor rated minimum 25% main bus rating.
- .4 All low voltage neutral 'XO' of the transformer shall be bonded to the transformer enclosure/frame with a minimum conductor sized as per Ontario Electrical Safety Code, Table 16.
- .5 Bond all interior non-electrical metallic piping systems to the electrical system ground including, but not limited to, water supply, wastewater, and gas systems.
- .6 Bond all conduit, and all non-current carrying metal parts, equipment cases, frames, bases, brackets, etc.

Grounding

- .7 Bond each piece of fixed equipment back to the switchboard or panel feeding that equipment, by one of the following methods:
 - .1 Where equipment is fed by a steel conduit, provided sizing is adequate, utilize conduit for the ground return conductor. At switchboard provide a grounding bushing, and strap such conduits to the ground bus (size per Code).
 - .2 Where the size of the conduit is inadequate (per Code), or if the conduit is flexible, install a separate insulated copper ground inside the conduit. At the switchboard or distribution panel, provide a grounding bushing, loop the ground conductor through the bushing, and connect to the switchboard ground bus. At the fixed equipment, connect to an internal ground bus, or connect to the inside of the metal enclosure utilizing approved screws and connectors (remove all paint).
 - .3 For branch circuits, the conduits may be used for grounding, provided seamless steel fittings are used on EMT and threaded fittings are used on rigid conduit. At each receptacle connect a stranded copper ground wire from the outlet box to the grounding terminal on the receptacle. Install a separate grounding conductor in all PVC conduits.
 - .4 Where equipment is fed by a multi-conductor power cable, provide a ground conductor in the cable. At the switchboard or panel, connect to the ground bus. Use a grounding connector on the cable for positive grounding of the metallic sheath. Loop the ground wire to the grounding connector.
- .8 Run a separate ground wire in all flexible conduits. Connect each end to ground bus or lug or connector.
- .9 Where mechanical protection is required for insulated grounding conductors install in rigid conduit. Use rigid PVC conduit in concrete or below grade slab and aluminum conduit in other locations.
- .10 Provide weld connection or mechanical grounding connectors for:
 - .1 All connections between grounding conductors.
 - .2 All connections to building steel.
 - .3 All connections between grounding conductors and cable lugs.
- .11 Where single ground conductor is in one conduit, the conduit must be non-ferrous.
- .12 Arrange grounding to provide the minimum impedance paths for ground fault currents. Provide any additional grounding required for approval by the inspecting authorities.

END OF SECTION

Switchboards

PART 1 - GENERAL

1.1 General Requirements

- .1 The General Conditions of CCDC-2 Division 1, form part of this section, and must be read in conjunction with the requirements of this section, and all related sections.
- .2 The work of this section, and related work specified in other sections shall comply with all requirements of Division 1 – General Requirements.
- .3 Conform to the conditions stated in the Contract Form and Supplementary Conditions.
- .4 This section of the Specification is an integral part of the Contract Documents and shall be read accordingly. This Section applies to and is a part of all Sections of Divisions 26.

1.2 Reference

- .1 Comply with the requirements of the latest edition of the following:
 - .1 CSA C22.2 No. 31 - Switchgear Assemblies.
 - .2 CSA C22.2 No. 29 – Panelboards.
 - .3 CSA C22.2 No. 5 – Molded Case Circuit Breakers.
 - .4 CSA C22.2 No. 4 – Enclosed Switches.

1.3 Submittals

- .1 Submit shop drawings in accordance with Section 26 01 00.

PART 2 - PRODUCTS

2.1 General

- .1 Switchboards shall be free-standing, dead front, non-walk-in front access only, sprinkler-proof enclosure and with ventilation on the assembly.
- .2 Steel channel base along the entire length of each switchboard assembly.
- .3 All bus bars, joints and connections of tinned copper and rated for current carrying capacity and short circuit bracing indicated on the Drawings. Design buses, joints and connections so that maximum temperature rise of any part of the switchboard will not exceed 50°C over an ambient temperature of 40°C.
- .4 A full length bare ground bus solidly bolted to the steel assembly with a momentary current-rating equal to or greater than the momentary rating of any of the apparatus in the assembly, and at least of 6 mm x 50 mm size.
- .5 A full capacity neutral insulated from the switchboard enclosure and run the full length of the board.

Switchboards

- .6 One coat of primer paint to the switchboard assembly after the surfaces have been properly cleaned and two finish coats of ASA #61 light grey paint. Furnish touch-up paint in pressurized spray cans.
- .7 Switchboard shall be suitable for service entrance application.
- .8 Auxiliary Customer Metering Compartments which shall include:
 - .1 Power Logic Digital Metering system capable of displaying voltage, current, KVA, KVAR, KW, PF, HZ, and the accumulated MWHR, and KW demand. It shall be capable of continuously monitoring and storing minimum values of volts and PF and maximum values of amps., - KW-KVA-KVAR-KWS.
All minimum/maximum values can be displayed.
KYZ Pulse output to BMS. 1pulse=1kwh.
Ethernet communications interface and all hardware/software.
Fieldserver RS232 to Ethernet Gateway and BACnet drivers for Ethernet and IP interface to BMS.
 - .2 All necessary instrument current and potential transformers and control protection devices.
- .9 The neutral conductor of the wiring system together with the conduit and service grounding system shall be bonded to the water service as detailed and in accordance with Hydro regulations.
- .10 All access to unmetered bus to be provided with bolted panels and provisions for sealing and padlocking.
Switchboard shall be provided c/w 200 kA TVSS surge protection system.

2.2 Metering

- .1 Metering transformers in metering compartments to the requirements of manufacturer.

2.3 Main Disconnect Devices

- .1 Main Circuit Breaker & Main Circuit Breaker
 - .1 Electronic trip molded case, full function, circuit breaker
 - .1 Shall be rated for 100% continuous current and be PowerPact P or R style breaker with MICROLOGIC trip system.
 - .2 Rated ampacity shall be 800A with 800A Trip setting
 - .2
 - .1 The entire trip system shall be a microprocessor-based, true rms sensing design and use digital programming techniques for the highest protection possible.

Switchboards

- .2 Provide the following time/current curve shaping adjustments to maximize system selective coordination. Each adjustment shall have discrete settings and each function is independent from all other adjustments.
 - .3 **LSIG**
 - .1 Adjustable Long Time Ampere Rating and Delay
 - .2 Adjustable Short Time Pickup and Delay (delay includes I²t IN and I²t OUT)
 - .3 Adjustable ground fault Time Pickup and Delay (delay includes I²t IN and I²t OUT)
 - .4 Adjustable Defeatable Instantaneous Pickup (with OFF position)
High Level Selective Override
 - .4 Circuit breaker shall be fixed mounted.
 - .5 Fault trip indication - indicating the element (long time, short time/instantaneous, ground fault) that has caused the circuit breaker to trip, indicated locally by a LED
- .2 Main Breaker for the Park
- .1 Install 100A breaker in Incoming wireway, this breaker is to be service entrance type connected by cable to load side of incoming breaker, this breaker will feed a meter socket to Hydro one Brampton requirements to feed the park loads.

2.4 Manufacturers

- .1 Acceptable manufacturers are:
 - .1 Schneider
 - .2 Cutler-Hammer
 - .3 Siemens
 - .4 Approved Equal

PART 3 - Execution

3.1 Installation

- .1 Install switchboards in accordance with manufacturer's written instructions, and applicable standards and safety codes.
- .2 Main switchboard on 100 mm concrete base.
- .3 Provide watertight connections for all services entering the top of the switchboard.
- .4 Provide main switchboard with SPD, refer to other specification sections for more information and comply accordingly.

Switchboards

3.2 Field Quality Control

- .1 Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.
- .2 Measure steady state load currents at each switchboard feeder; rearrange circuits in the switchboard to balance the phase loads within 20% of each other. Maintain proper phasing for multi-wire branch circuits.
- .3 Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

END OF SECTION

Panelboards

PART 1 - GENERAL**1.1 General Requirements**

- .1 The General Conditions of CCDC 2 and the General Requirements of Division 1, form part of this section, and must be read in conjunction with the requirements of this section, and all related sections.
- .2 Provide factory assembled panelboards as herein specified and as shown on the Electrical Drawings.
- .3 Refer to the Electrical Drawings for: voltage; phase; size and type of mains; size, type and quantity of the branch devices; location; surface or flush mounting.

1.2 References

- .1 Comply with the requirements of the latest editions of the following:
 - .1 CSA C22.2 No. 29 - Panelboards and Enclosed Panelboards.
 - .2 CSA C22.2 No. 5 - Molded Case Circuit Breakers.
 - .3 CSA C22.2 No. 4 - Enclosed and Dead-Front Switches.

1.3 Submittals

- .1 Submit Shop Drawings and Product data in accordance with Section 260100 – Electrical General Requirements.
- .2 Shop Drawings shall include electrical details and dimensions of panel, branch circuit device (breaker and switch) type, quantity and ampacity.

1.4 Manufacturers

- .1 The manufacturer of the panelboards shall be the manufacturer of the major components within the assembly, including circuit breakers and fusible switches.
- .2 Product of one manufacturer for entire project. Acceptable manufacturers are:
 - .1 Cutler-Hammer
 - .2 Schneider
 - .3 Siemens
 - .4 Approved Equal

Panelboards

PART 2 - PRODUCTS

2.1 Ratings

- .1 Panelboards rated 120/208 volt AC shall have short-circuit rating as shown on the Drawing, but not less than 14 kA RMS symmetrical.
- .2 Panelboards shall be labeled with the short-circuit rating.
- .3 Where series ratings are applied, provide the labels in accordance with the requirements of Electrical Safety Code. The labels shall state but not limited to:
 - .1 Size and type of upstream devices;
 - .2 Branch devices that can be used;
 - .3 Short-circuit rating.

2.2 Construction

- .1 Interiors shall be completely factory assembled devices.
- .2 Enclosure:
 - .1 Indoor dry locations: CSA type 1.
 - .2 Indoor sprinkler locations: CSA type 2.
 - .3 Outdoor locations: CSA type 3R.
- .3 Provide doors with concealed hinges, combined locks and latches for all panelboards except fusible disconnect switch type distribution panelboards.
- .4 Two (2) keys for each panelboard and key all panelboards alike.
- .5 Interior trim shall be dead-front construction to shield user from energized parts.
- .6 Main bus shall be tin finished high quality copper and extend the full length of the panel. Ground bus shall be sized to accommodate branch circuit grounding conductors. 200% neutral as required.
- .7 Sequence phase bussing with odd numbered sections on left and even on right, with each section identified by permanent number identification as to circuit number and phase.
- .8 Provide bolt-on type circuit breakers and/or disconnect switch units.
- .9 Means of locking off to meet the Department of Labour requirements for elevator panelboards.
- .10 Minimum circuits shall be 42, unless otherwise noted.
- .11 Trims and doors shall be painted ANSI 61 grey. Factory applied paint finish on all exterior surfaces.
- .12 All required lugs.
- .13 Connectors for future breakers and switches. Drill and tap bus work.

Panelboards

2.3 Custom Built Panelboard Assemblies

- .1 Double stack panels as indicated.
- .2 Contactors and/or relays as indicated.
- .3 Feed-through and/or sub-feed lugs as indicated.
- .4 Special ground buses as indicated.
- .5 Special neutrals as indicated.
- .6 Connectors for future branch devices as indicated.
- .7 TVSS as indicated.
- .8 Isolated ground bus as indicated.

2.4 Circuit Breakers

- .1 Circuit breakers shall be quick-make, quick-break type, for manual and automatic operation, with over centre toggle handle. The handle shall reside in a position between "ON" and "OFF".
- .2 Circuit breakers shall have thermal and magnetic trip mechanism, to provide inverse time current tripping and instantaneous tripping, trip-free and trip indicating. Circuit breakers rated at 125A and larger shall have thermal and adjustable magnetic trip mechanism.
- .3 Multi-pole breakers shall be common trip type and have a common handle. Tie handles are not acceptable.
- .4 Clearly marked with their rated ampacity and respective trip rating and visible without removing bolted covers.
- .5 Provide handle locking devices on all branch circuit breakers controlling communication equipment, lighting control, exit signs, emergency lighting, fire alarm system and other life safety equipment.
- .6 Circuit breakers feeding unswitched lighting circuits shall be "switching duty" type.
- .7 Provide class 'A' ground fault protection with the circuit breaker, where required by Electrical Safety Code.

2.5 Equipment Identification

- .1 Provide equipment identification in accordance with related section.
- .2 Identify circuits controlled by each breaker on directory cards provided with panels. Directories shall be typed and mounted in metal frame with clear plastic cover.

Panelboards

PART 3 - EXECUTION

3.1 Installation

- .1 Install panelboards securely, plumb, true and square, to adjoining surface.
- .2 Provide three (2) empty 35 mm (1 ¼") conduits from all recessed lighting and receptacle panelboards, terminated in ceiling space above.
- .3 Provide three (3) empty 53 mm (2") conduits from all recessed distribution panelboards, terminated in ceiling space above.

END OF SECTION

Disconnect Switches

PART 1 - GENERAL

1.1 General Requirements

- .1 The General Conditions of CCDC 2 and the General Requirements of Division 1, form part of this section, and must be read in conjunction with the requirements of this section, and all related sections.
- .2 Provide all disconnect switches, whether an integral part of equipment or separately mounted. Refer to Electrical Drawings for switches' voltage, ampacity and number of poles.

1.2 Reference

- .1 Comply with the requirements of the latest edition of the following:
 - .1 CSA C22.2 No. 4, Enclosed and Dead-Front Switches.
 - .2 CSA C22.2 No. 39, Fuseholder Assemblies.
 - .3 CSA C22.2 No. 248 (Part 1 to Part 16), Low Voltage Fuses.

1.3 Submittals

- .1 Submit Shop Drawings and Product data in accordance with Section 260100 – Electrical General Requirements.
- .2 Product data: switches' ratings and enclosure dimensions.

PART 2 - PRODUCTS

2.1 Disconnect Switches

- .1 Enclosure:
 - .1 Indoor dry locations: CSA Type 1.
 - .2 Indoor sprinkler locations: CSA Type 2.
 - .3 Outdoor locations: CSA Type 3R.
- .2 Provision for padlocking in off switch position by locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated.
- .5 Fuse holders: suitable without adaptors, for type and size of fuse indicated.
- .6 Heavy-duty horsepower rated, quick-make, quick-break action, front operation, with integral handle mechanism and visible contacts in "OFF" position.
- .7 ON-OFF switch position indication on switch enclosure cover.

Disconnect Switches

- .8 Switches identified for use as service equipment are to be labelled for this application.
- .9 Furnish solid neutral assembly and equipment ground bar.
- .10 Lugs suitable for copper conductors.

2.2 Equipment Identification

- .1 Provide equipment identification in accordance with Section of 260500.
- .2 Indicate name of load controlled.

2.3 Manufacturers

- .1 Product of one manufacturer for entire project. Acceptable manufacturers are:
 - .1 Cutler-Hammer
 - .2 Schneider
 - .3 Siemens

2.4 Fuses

- .1 Fuses up to 600 volts and over 600amps:
 - .1 Where used in motor, transformer and other circuits with an inrush: Class L time delay. Ferraz Shawmut type A4BT or equal by Bussman or GE.
 - .2 All remaining fuses: Class L non-time delay. Ferraz Shawmut A4BY or equal by Bussman or GE.
- .2 Fuses up to 600 volts and up to and including 600amps:
 - .1 Where used in motor, transformer and other circuits with an inrush: Class J time delay. Ferraz Shawmut type AJT or equal by Bussman or GE.
 - .2 All remaining fuses: Class J non-time delay. Ferraz Shawmut type A4J or equal by Bussman or GE.
- .3 Fuse storage cabinet: Wall-mounted sheet metal cabinet with shelves, suitable sized to store spare fuses and fuse pullers, complete with hinged door.

PART 3 - EXECUTION

3.1 Installation

- .1 Install disconnect switches complete with fuses if applicable.
- .2 In finished areas, where disconnecting devices are required, provide a circuit breaker in flush mounted enclosure.

Disconnect Switches

- .3 Provide three spare fuses of each type and size used above 600 amp and six spare fuses of each type and size used up to and including 600amp.
- .4 Install fuses in mounting devices immediately before energizing circuit.
- .5 Ensure correct fuses fit to physically match mounting devices.
- .6 Ensure correct fuse fitted to assigned electrical circuit.
- .7 Mount the fuse storage cabinets on the wall in electrical rooms. Mount the spare fuses in clip neatly arranged and labeled.

END OF SECTION

Lighting Equipment

PART 1 - GENERAL**1.1 Summary**

- .1 This section of specification is an integral part of the contract documents and shall be read accordingly.
- .2 Comply with Section 260100 – Electrical General Requirements.
- .3 Provide all lighting fixtures with lamps, ballasts and accessories as specified herein and as shown on the Electrical Drawings.

1.2 Reference

- .1 Comply with all requirements of the latest edition of CSA Standards.

1.3 Submittals

- .1 Submit shop drawings in accordance with Section 260100.
- .2 Include fixture catalogue data sheets with shop drawings. Arrange the fixture catalogue data sheets and identify in the same sequence as the specified fixture list. Fixture catalogue data sheets shall indicate the following:
 - .1 Dimensions, weight, material, finish and mounting details.
 - .2 Performance: Candle power distribution curves in two planes, C.V. chart of indoor fixtures and lumen output chart of outdoor fixtures and flood lights.
 - .3 Pole wind loading, weight, dimension, anchoring details and finish.
 - .4 Lamps: type and base, burning hours, CRI, CCT and lumens.
 - .5 Ballasts: type, wiring diagram, watts, voltage, P.F., sound rating, starting temperature, efficiency and other required characteristics.
- .3 Where requested, submit fixture samples of each substituted fixtures.
- .4 Submit color/finish chart for all lighting fixtures for final selection/approval.
- .5 Where requested, submit certified heat-run test data for each type of ballast mounting.
- .6 Where requested, within four (4) weeks of Contract award, provide information on electronic ballast operating frequency for Owner's co-ordination with Owner supplied equipment operating at high frequencies.

1.4 Warranty

- .1 Warrant LED lamps and drivers for a period of minimum 5 years from the date of acceptance of the work. Include labour for replacing lamps and drivers in the warranty.

Lighting Equipment

PART 2 - PRODUCTS

2.1 Drivers for LED Fixtures

- .1 Electronic Driver for LED Fixtures: Comply with UL 1310 Class 2 requirements for dry and damp locations. Include the following features unless otherwise indicated:
 - .1 Rated for 50,000 hours of life, unless otherwise noted.
 - .2 Sound Rating: Class A.
 - .3 Total Harmonic Distortion Rating: 20 percent or less.
 - .4 5 year warranty on the whole fixture including all components, minimum.
 - .5 Approved Manufacturer: Philips Advance or approved equal.

2.2 LED Light Fixtures

- .1 Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.
- .2 Include the following features unless otherwise indicated:
 - .1 Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply). Minimum of two drivers for two step dimming (50% and 100%) luminaires.
 - .2 Luminaire optics shall consist of precision formed optical assembly with positively retained high grade high transmittance translucent polycarbonate lens.
 - .3 Each luminaire shall be rated for a minimum operational life of 50,000 hours (L70 compliance) utilizing a minimum ambient temperature of (25°C).
 - .4 Complies with LM-80 Standards.
 - .5 Color Rendering Index (CRI) of 80 at a minimum.
 - .6 Color temperature 3500oK, unless otherwise indicated.
 - .7 Fixture efficacy of 111 Lumens/Watt, minimum.
 - .8 Fixture depth shall be no greater than 7".
 - .9 5 year luminaire warranty, minimum.
 - .10 Photometry must comply with IESNA LM-79.
 - .11 Luminaries shall be Design Lights Consortium Qualified wherever applicable (depends on fixture type being used and application, doesn't apply to potlights – Energy Star rating is more appropriate for these).
 - .12 The individual LEDs shall be constructed such that a catastrophic loss of the failure of one LED will not result in the loss of the entire luminaire.

Lighting Equipment

- .13 Luminaire shall be constructed such that driver may be replaced or repaired without the replacement of the whole fixture.
 - .14 Luminaires shall be UL 1598 and UL 2043 listed.
 - .15 Luminaires shall have natatorium finish, gasketed, sealed and suitable for pool application.
- .3 Technical Requirements
- .1 The luminaire shall not consume power in the off state.
 - .2 Operation Voltage: The luminaire shall operate from a 50 HZ to 60 HZ AC line over a voltage ranging from 120 VAC to 277 VAC/XX. The fluctuations of line voltage shall have no visible effect on the luminous output.
 - .3 Power Factor: The luminaire shall have a power factor of 0.9 or greater.
 - .4 THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent.
 - .5 Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.
- .4 Thermal Management
- .1 The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
 - .2 Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
 - .3 The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.
- .5 Fixture Schedule, See Drawings for Lighting Fixtures Schedule.

2.3 Wiring

- .1 Refer to basic materials and methods.

PART 3 - EXECUTION

3.1 Installation

- .1 Install all fixtures in the standard manner for the type of fixture and in accordance with the manufacturer's instructions. Support all fixtures from structural members except the fixtures installed in suspended ceilings may be supported by the ceiling where the ceiling supports are reinforced to carry the weight of the fixtures. Co-ordinate with Division 9 and submit written confirmation to the requirements of the Inspection Authority.

Lighting Equipment

- .2 In non-accessible ceilings wire with not less than 1220 mm AC90 or RW90 wire in flexible conduit to adjacent outlet boxes placed above finished ceiling within reach of the fixture openings.
- .3 In accessible ceilings wire with 1830 mm AC90 or RW90 wire in flexible conduit to adjacent outlet boxes.
- .4 Where fixtures are not installed in approved ceiling system, provide steel fixture studs, brackets and hangers. Where fixtures are hung on chain hangers, provide chain of closed link type capable of supporting ten times the fixture weight. Use U-bolts for chain ends; S-hooks are not acceptable.
- .5 Provide suitable trim for all fixtures installed in drywall ceiling or within lay in or snap in tiles.
- .6 Provide I.C. frame/enclosure for all fixtures installed in insulated ceiling. Confirm the insulated ceiling areas with Architect. Provide fire rated boxes for all recessed fixture in fire rated ceiling area.
- .7 Provide plaster frames for all fixtures recessed in plaster ceilings. Have plaster frames installed under Division #9 and ensure that they are located correctly. Pay for all work associated with this work.
- .8 Protect fixtures from dirt and damage during construction and clean when the installation is completed. Replace fixtures showing marks or scratches due to handling or tool marks.
- .9 Align fixtures shown in continuous rows or broken lines so that all rows appear as straight lines. Crooked lines and misplaced fixtures will not be accepted.
- .10 Where luminaries are surface mounted on inverted T-bar ceilings, they shall be supported directly from the building structure. Where this is not possible due to presence of mechanical ducts or other obstruction, supply and install galvanized steel channel, Unistrut or equal, above the ceiling, securely attached to the structure and not from the suspension system for the ceiling and fasten the luminaires to the channel with clamping nut, bolt, flat washers and lock washer to the satisfaction of the Consultant. Provide bolts at least every 1.2m length of fixture (i.e., 3 bolts for 2.4m fixture).
- .11 Fixtures are shown on the electrical drawings in approximate locations only. Install fixtures in accordance with reflected ceiling plans, details and/or field instructions issued by the Engineer.
- .12 Install lighting fixtures in service areas, underground parking areas, unfinished areas, mechanical and electrical rooms after the mechanical and electrical equipment is in place. Locate fixtures on site to clear all obstructions to the approval of DCC. Provide auxiliary steel members for hanging fixtures below ducts and other equipment. Where ceiling height is more than 3 metres, suspend ceiling surface mounted fixtures at 3 metres AFF. Where ceiling height is more than 3 metres, suspend ceiling surface mounted fixtures at 3 metres AFF.
- .13 Provide all mounting hardware for all fixtures.

Lighting Equipment

- .14 Check the latest ceiling finishes in all areas where recessed fixtures are specified to ensure that fixtures are purchased with suitable ceiling trim for the particular ceiling finish. Replace fixtures which are sent to the site with wrong ceiling trim or flanges with fixtures having the correct trims, flanges, etc. as required without additional cost.
- .15 Provide safety chains for all HID fixtures with integral ballasts. Attach chain to fixture and building structure. Safety chain to be designed and secured so as to sustain the sudden weight of the fixture.
- .16 In stairs, provide fixture on every main and half landing level. Co-ordinate with Architectural drawings for number of landings.
- .17 Fixtures shall be installed in accordance with the reflected ceiling layouts with due consideration for mechanical diffusers, bulkheads, sprinkler heads, and other obstructions. Check Mechanical and Architectural drawings before roughing-in to avoid any possible conflict.
- .18 Fixtures connected to ground fault interruptor circuits shall have separate neutrals (common neutrals for 2 or 3 circuits are not acceptable).
- .19 Exterior wall mounted lighting fixtures shall be mounted on recessed boxes except where fixtures with integral outlet boxes are specified in which case the recessed outlet box is not required. Outlet boxes shall be firmly anchored to the wall.
- .20 Unless otherwise indicated supply and install concrete bases for lighting standards. Concrete bases shall be trowel finished with all exposed corners beveled at 45 degrees. Junction boxes shall be carefully set and anchored to ensure flush fit of junction box cover. Concrete bases shall be constructed of 20 Mpa concrete air entrained and steel reinforced as shown on the Drawings.

END OF SECTION

Emergency Lighting System

PART 1 - GENERAL

1.1 Summary

- .1 This section of Specification is an integral part of the Contract Documents and shall be read accordingly.
- .2 Comply with general CCDC2 2008 and City of Burlington Supplementary Conditions, and section 260100 – Electrical general requirements.
- .3 Provide emergency lighting system including exit signs, remote heads, and battery units, as shown on the Drawings, as specified herein and as otherwise required.

1.2 Reference

- .1 Comply with the requirements of the latest edition of the following:
 - .1 CSA-C22.2 No. 9, General Requirements for Luminaires.
 - .2 CSA-C22.2 No. 141, Unit Equipment for Emergency Lighting.
 - .3 CSA-C22.2 C860, Performance of Internally Lighting Exit Signs.

1.3 Submittals

- .1 Submit Shop Drawings and Product Data in accordance with Section 260100.
- .2 Include fixture catalogue data sheets with Shop Drawings indicating dimensions, components, electrical characteristics and performance data for each fixture and device. Arrange the fixture catalogue data sheets and identify in the same sequence as the specified fixture list.
- .3 Submit test report and verifications following the completion of testing.

1.4 Warranty

- .1 For complete system, provide a 2-year no-charge, unconditional guarantee, and 5-year pro-rate charge guarantee on workmanship and parts.
- .2 For batteries, on the second 5-year, provide a pro-rate charge guarantee on workmanship and parts.

PART 2 - PRODUCTS

2.1 Runningman Exit Signs

- .1 Extruded aluminum pictogram exit sign.
- .2 Lamps: Less than 2W, LED.
- .3 Inputs:
 - .1 DC: 24V as shown.
 - .2 AC: Universal: 120V/347V.

Emergency Lighting System

- .4 Directional arrows: universal type for field adjustment.
- .5 Mounting: wall or ceiling recessed for field selection.
- .6 Beghelli-Quadra Series.
- .7 Include for the supply, installation and wiring (to nearest normal & emergency lighting circuit) of 5 additional exit signs at locations later directed on site.

2.2 Weatherproof Exit Signs

- .1 Same as standard exit signs, except:
 - .1 Housing to be industrial grade polyvinyl chloride fully gasketed around lens and canopy.
 - .2 The sealed face plate shall be constructed of heavy duty vandal-resistant polycarbonate.

2.3 Standard Remote Heads

- .1 Single or double cast aluminum head(s), complete with mounting plates, 300 degree horizontal and 80 degree vertical minimum adjustment. Vandal resistant polycarbonate cube.
- .2 Lamps: 7W MR16 LED.
- .3 Input: 24VDC.
- .4 Mounting: ceiling or wall as shown.
- .5 eghelli #BTMR series

2.4 Weatherproof and Vandal Resistant Remote Heads

- .1 Same as standard remote heads, except:
Fully gasketed cast aluminum back plate with clear polycarbonate vandal resistant cover.

2.5 Battery Unit

- .1 Supply voltage: as indicated on the Electrical Drawings.
- .2 Output voltage: 24V DC.
- .3 Operating time: 1/2 hour minimum.
- .4 Battery: sealed, maintenance free, long-time lead with rated life of ten (10) years.

Emergency Lighting System

- .5 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01V for plus or minus 10% input variations capable of restoring a discharged battery to the fully-charged state within twenty-four (24) hours, and switched to a float charge when not in full charge mode.
- .6 Solid state transfer circuit.
- .7 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .8 Signal lights: solid state, for "AC Power ON" and "High Charge".
- .9 Lamp heads: integral on unit and remote, 345° horizontal and 180° vertical adjustment, white painted cast aluminum head. Lamp type: wide beam flat 2-20W, unless noted otherwise.
- .10 Cabinet: suitable for direct or shelf mounting to wall and complete with knockouts for conduits. Removable or hinged front panel for easy access to batteries.
- .11 Finish: standard factory finish.
- .12 Auxiliary equipment:
 - .1 Advanced diagnostic printed circuit board with auto self test and time delay.
 - .2 Test switch and LED trouble indicator.
 - .3 Battery disconnect device.
 - .4 AC input and dc output terminal blocks inside cabinet.
 - .5 Mounting shelf.
 - .6 Transient voltage surge suppressor on the supply side of power to the unit.

2.6 Acceptable Emergency Equipment Manufacturers

- .1 Lumacell
- .2 Luxnet
- .3 Emergi-lite

PART 3 - EXECUTION

3.1 Installation

- .1 Pendant mount exit sign in service rooms and other areas where necessary to clear obstructions. Install suspended exit signs using pendants supported from swivel hangers.
- .2 Install all unit equipment, remote heads, exit signs, and accessories in accordance with manufacturer's instruction.
- .3 Direct heads for illumination to meet OBC requirements.

Emergency Lighting System

3.2 Testing and Verification

- .1 Arrange with the manufacturer to conduct a complete inspection and test of all installed emergency lighting system.
- .2 Manufacturer's representative shall be responsible for properly aiming remote heads, recording the light level readings, recording battery full load operation time, issuing a verification indicating that lighting levels meet OBC requirements, and the system has been installed properly.
- .3 Submit report and verification to Consultant.
- .4 Correct all deficiencies.
- .5 Witnessed by Consultant.
- .6 All cost involved in testing, verification, and corrections shall be included in the Tender Price.

END OF SECTION

Lighting Control System

PART 1 - GENERAL

1.1 Summary

- .1 Section Includes:
 - .1 Networked Central Lighting Control systems. Systems are composed of:
 - .1 Network integrated power switching systems.
 - .2 Network integrated dimming systems.
 - .3 Standalone power switching and dimming systems.
 - .4 Automation control processors.
 - .5 Sensors
 - .6 User Interfaces:
 - .1 Keypad
 - .2 Touch screen
 - .3 Virtual touch screen
 - .7 System Functions and Sequences
 - .2 Related Requirements:
 - .1 Edit the following paragraphs to coordinate with other sections in the Project Manual.
 - .2 Section 12 24 13 Roller Window Shades
 - .3 Section 25 08 00 Commissioning of Integrated Automation
 - .4 Section 25 10 00 Integrated Automation Network Equipment
 - .5 Section 25 11 13 Integrated Automation Network Servers
 - .6 Section 25 13 13 Integrated Automation Control and Monitoring Network Supervisory Control
 - .7 Section 25 13 19 Integrated Automation Control and Monitoring Network Interoperability
 - .8 Section 25 15 16 Integrated Automation Software for Control and Monitoring Networks
 - .9 Section 26 05 00 Common Work Results for Electrical
 - .10 Section 26 27 26 Wiring Devices
 - .11 Section 26 51 00 Interior Lighting
 - .12 Section 27 15 00 Communications Horizontal Cabling
 - .13 Section 27 41 00 Audio-Video Systems

Lighting Control System

1.2 References

.1 Definitions:

- .1 Control: Effecting a change in state by one PC program onto a microprocessor or device.
- .2 Scene: Predetermined light level of a single fixture or group of fixtures.
- .3 DALI: Digital addressable lighting interface.
- .4 RS-485: A serial network protocol complying with TIA-485-A.
- .5 UTP: Unshielded twisted pair.

.2 Reference Standards:

- .1 California Energy Commission (CEC):
- .2 CEC CCR Title 24, Part 6: California Energy Efficiency Standards for Residential and Nonresidential Buildings, California's Appliance Energy Efficiency program: Listed for lighting control devices.
- .3 National Fire Protection Association (NFPA):
- .4 NFPA 70 - National Electrical Code.
- .5 Underwriters Laboratories (UL)
 - .1 UL 508 – Industrial Control Equipment.
 - .2 UL924 – Emergency Lighting and power Equipment.
 - .3 UL1008 – Transfer Switch Equipment.

1.3 Requirements

.1 Coordination

- .1 Contractor shall place daylight and occupancy sensors per plans to achieve optimal performance. Proper placement shall be coordinated with others in order to avoid interference with prescribed lighting levels.
- .2 Contractor shall provide luminaires and lamps that are compatible with the lighting control system to be installed.
- .3 Contractor shall locate touch screen and keypad stations as per plans.
- .4 Contractor shall notify engineer of record of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.4 System Description

- .1 Web Accessible, network connected, lighting control system utilizing preset control software, central signal microprocessor, lighting control panel including power switching modules and relays, dimming modules and Sensors User Interfaces.
- .2 System Components: System includes the following addressable components:
 - .1 Keypad controls.

Lighting Control System

- .2 Touch screen controls.
- .3 Window treatment controls.
- .4 Remote occupancy sensors.
- .5 Lighting load shedding.
- .6 Timed room lighting.
- .7 Daylight compensating lighting controls.
- .8 Communication interface to facility-wide room management system.
- .9 Communication interface to building automation system gateway/interface.

1.5 Submittals

- .1 Product Data: For each type of product required for complete network lighting control system, demonstrating compliance with requirements.
- .2 Product Data: For each type of product required for complete network lighting control system, demonstrating compliance with requirements.
- .3 Shop Drawings: Indicated the following:
 - .1 Schematic diagram showing complete network lighting control system and accessories.
 - .2 Circuits and emergency circuits with capacity and phase, control zones, load type and voltage per circuit.

1.6 Closeout Submittals

- .1 Operating and maintenance manuals.

1.7 Quality Assurance

- .1 Manufacturer Qualification: Manufacturer of network lighting controls with minimum five years record of satisfactory manufacturing and support of components comparable to basis of design system.
- .2 Source Requirements: Provide Network Lighting System through a single source from a single manufacturer.
- .3 Manufacturer Qualifications: Approved manufacturer of network lighting controls listed in this Section with minimum five years record of satisfactory manufacturing and support of components comparable to basis of design system.
 - .1 Approval of Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review:
 - .1 Product data, including certified independent test data indicating compliance with requirements.
 - .2 Samples of each component.
 - .3 Sample submittal from similar project.

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- .4 Project references: Minimum of 5 installations not less than 5 years old, with Owner and Architect contact information.
- .5 Sample warranty.
- .2 Substitutions following award of contract are not allowed except as stipulated in Division 01 General Requirements.
- .4 Approved manufacturers must comply with separate requirements of Submittals Article.
- .5 Electrical Components, Devices, and Accessories: UL listed and labeled per NFPA 70.
- .6 California Appliance Efficiency Listing: Provide products that comply with provisions of CEC CCR Title 24, Part 6.

1.8 Coordination

- .1 Coordinate integrated lighting and dimming controls with systems and components specified in the following sections:
 - .1 Division 11 Section "Audio-Visual Equipment".
 - .2 Division 12 Section "Window Treatments".
 - .3 Division 23 Section "Instrumentation and Control for HVAC".
 - .4 Division 25 Section "Integrated Automation Control of Electrical Systems".
 - .5 Division 26 Section "Panelboards".
 - .6 Division 26 Section "Wiring Devices".
 - .7 Division 26 Section "Lighting Devices".
 - .8 Division 26 Section "Interior Lighting".
 - .9 Division 27 Section "Communications Horizontal Cabling".
 - .10 Division 27 Section "Audio-Video Systems".
 - .11 Division 28 Section "Electronic Access Control and Intrusion Detection".

1.9 Project Conditions

- .1 Environmental Conditions Range:
 - .1 Temperature: 32 – 104 deg F (0 - 40 deg C).
 - .2 Relative Humidity: 10 – 90 percent, noncondensing.

Lighting Control System

1.10 Warranty

- .1 Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of modular dimming controls system the fail in materials or workmanship within the specified warranty period following substantial completion.
 - .1 Warranty Period: Commercial lighting dimmers and switches, sensors, keypads, lighting enclosures, terminal blocks, power supplies, thermostats, and control processors, when dedicated for use as part of a commercial lighting control system: 5 year warranty
 - .2 Manufacturer's Extended Support Service: Extended telephone support: Unlimited period.

PART 2 - PRODUCTS

2.1 Manufacturers

- .1 MANUFACTURERS: Subject to compliance with requirements, provide products by one of the following Manufacturers:
 1. Crestron Electronics INC
 - .2 Substitutions:
 1. Refer to Section 01 25 00.

2.2 General

- .1 Contractor shall provide system hardware that is manufactured and warranted by a single manufacturer.
- .2 Provide control system with compatibility for BACNET/IP.
- .3 System shall provide time clock functionality as well as support for multiple interface devices.
- .4 System must automatically adjust for daylight savings time and leap year.

2.3 Sum Wired Dimming Solutions

- .1 Load Controllers
 - .1 ZUMNET-Junction Box Zone Controllers
 - .1 Junction box mounted using ½" knockout.
 - .2 120/277 VAC input
 - .3 Real-time Power monitoring
 - .4 Connections
 - .1 ZUMLINK RJ45 ports x 2 (Cresnet)
 - .2 ZUMNET RJ45 ports x 2 (Ethernet)
 - .3 Occ Sensor Input (24V, G, OCC)

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- .4 Photo Sensor Input (24V, G, PHO)
- .5 Override Input (OVR, G)
- .6 Integrated Ethernet Switch allowing daisy chaining (up to 20 devices)
- .5 Products:
 - .1 CRESTRON ZUMNET-JBOX-16A-LV (16A, 0-10V)
 - .2 CRESTRON ZUMNET-JBOX-16A-DALI (16A, 1 DALI LOOP)
- .2 ZUMLINK-Junction Box Zone Controllers
 - .1 Junction box mounted using ½” knockout.
 - .2 120/277 VAC input
 - .3 Real-time Power monitoring
 - .4 Connections
 - .1 ZUMLINK RJ45 ports x 2 (Cresnet)
 - .2 Occ Sensor Input (24V, G, OCC)
 - .3 Photo Sensor Input (24V, G, PHO)
 - .4 Override Input (OVR, G)
 - .5 Products:
 - .1 CRESTRON ZUMLINK-JBOX-16A-LV (16A, 0-10V)
 - .2 CRESTRON ZUMLINK-JBOX-20A-SW (20A, SWITCHED)
 - .3 CRESTRON ZUMLINK-JBOX-20A-PLUG (20A, SWITCHED PLUG LOAD)
 - .4 CRESTRON ZUMLINK-JBOX-DIMU. (5A UNIVERSAL PHASE DIMMING)
- .3 Economy ZUMLINK-Junction Box Zone Controllers
 - .1 Junction box mounted using ½” knockout.
 - .2 120/277 VAC input
 - .3 Real-time Power monitoring
 - .4 Connections
 - .1 ZUMLINK RJ45 ports x 2 (Cresnet)
 - .5 Products:
 - .1 CRESTRON ZUMLINK-JBOX-16A-LV-ECON (16A, 0-10V)
- .4 Emergency ZUMLINK-Junction Box Zone Controllers
 - .1 Junction box mounted using ½” knockout.
 - .2 120/277 VAC input
 - .3 Real-time Power monitoring
 - .4 UL-924 Certified

Lighting Control System

- .5 Connections
 - .1 ZUMLINK RJ45 ports x 2 (Cresnet)
 - .2 Occ Sensor Input (24V, G, OCC)
 - .3 Photo Sensor Input (24V, G, PHO)
 - .4 Override Input (OVR, G)
- .6 Products:
 - .1 CRESTRON ZUMLINK-JBOX-16A-LV-EM (16A, 0-10V)
- .2 User Interfaces
 - .1 ZUMLINK-keypads
 - .1 Field configurable remote keypad , engravable programmable buttons in number indicated, with Single Green LED indicator, configured to fit in standard single-gang box.
 - .2 Trimmed using decorator style faceplate (not included) or Crestron decorator-style faceplates (FP-G series)
 - .3 RJ45 connection for power and communication (2 x RJ45 ZUMLINK ports facing up)
 - .4 Bluetooth connectivity
 - .5 Colors White, Gray, Black, Red
 - .6 Minimum Buttons: 2, Maximum Buttons:8. (engraving options available)
 - .1 Button kits required
 - .1 ZUMLINK-BTNR
 - .2 ZUMLINK-BTN2
 - .3 ZUMLINK-BTN4
 - .4 ZUMLINK-BTN6
 - .5 ZUMLINK-BTN8
 - .7 Color shall be White
 - .8 Mounting: Mounts in a 1-gang or larger electrical box or mud ring
 - .9 Products
 - .1 ZUMLINK-KP-R
 - .2 ZUMLINK-ZAP
 - .1 Wireless Access Point for ZUMMESH system integration
 - .2 Mounting: Mounts in a 1-gang box.
 - .3 RJ45 connection for power and communication (2 x RJ45 ZUMLINK ports)

Lighting Control System

- .4 Supports integration of ZUMMESH wireless communication products using a Wi-Fi friendly 2.4 GHz peer-to-peer mesh network topology.
- .5 Supports integration of 6 zummesh battery devices and 20 AC powered devices
- .6 Product: ZUMLINK-ZAP
- .3 ZUMLINK-IO
 - .1 Control Port Expansion Module
 - .1 4 x Contact Closure Inputs
 - .2 2 x Contact Closure Outputs
 - .3 Bi-directional RS232 for room control
 - .2 RJ45 ZUMLINK connection for power and communication (2 x RJ45 ZUMLINK ports)
 - .3 Product: ZUMLINK-IO
- .3 Motion Sensors
 - .1 Product: ZUMLINK-DT-QUATTRO-DLS
 - .1 Characteristics
 - .1 Sensing Technology: Passive infrared (PIR), single pyro, 11 detection levels, 520 switching zones, ultrasonic 40 kHz.
 - .2 Mounts to a 4" octagon box.
 - .3 Time Delay Setting
 - .4 Light Level Setting: 1 - 100 fc (10 - 1000 lux)
 - .5 Dip Switch Settings
 - .6 HVAC dry contacts: (COM2 Version only)
 - .7 Test Mode: Dip switch setting or programming remote
 - .8 Ultrasonic Coverage at 9 feet (2.7 m):
 - .1 Presence: Maximum 20 feet by 20 feet (6 by 6 m) or 400 sf (36 sm).
 - .2 Radially and Tangentially: Maximum 32 feet by 32 feet (10 by 10 m) or 1,000 sf (100 sm).
 - .9 PIR Detection Zones:
 - .1 Presence: Maximum 10 feet by 10 feet (3 by 3 m) or 100 sf (9 sm).
 - .2 Radially: Maximum 13 feet by 13 feet (4 by 4 m).
 - .3 Tangentially: Maximum 26 feet by 26 feet (8 by 8 m).

Lighting Control System

.4 PIR Motion Sensors

.1 Product: ZUMLINK-IR-QUATTRO-HD-DLS

.1 Characteristics

- .1 Sensing Technology: Passive infrared (PIR)
- .2 Mounts to a 4" octagon box.
- .3 Delay Setting
- .4 Light Level Setting: 1 - 100 fc (10 - 1000 lux)
- .5 Dip Switch Settings
- .6 HVAC dry contacts: (RLY Version Only)
- .7 Test Mode: Dip switch setting or programming remote
- .8 Coverage at 9 feet (2.7 m): 360 deg square mechanically scalable detection zones.
 - .1 Presence: Maximum 25.5 feet by 25.5 feet (7.9 by 7.9 m) or 650.25 sf (62.4 sm).
 - .2 Radially: Maximum 25.5 feet by 25.5 feet (7.9 by 7.9 m) or 650.25 sf (62.4 sm).
 - .3 Tangentially: Maximum 65.5 feet by 65.5 feet (20 by 20 m) or 4,290.25 sf (400 sm).

.5 Ultra Sonic Motion Sensors

.1 Product: ZUMLINK-US-HALLWAY-DLS [RLY]

.1 Characteristics

- .1 Sensing Technology: Ultrasonic
- .2 Mounts to a 4" octagon box.
- .3 Delay Setting
- .4 Light Level Setting: 1 - 100 fc (10 - 1000 lux)
- .5 Dip Switch Settings
- .6 HVAC dry contacts: (RLY Version only)
- .7 Test Mode: Dip switch setting or programming remote
- .8 Coverage at 9 feet (2.7 m): Maximum 6.5 feet by 65 feet (2 by 20 m) or 422.5 sf (40 sm).

.2 Product: ZUMLINK-US-ONEWAY-DLS

.1 Characteristics

- .1 Sensing Technology: Ultrasonic
- .2 Mounts to a 4" octagon box.

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- .3 Delay Setting
- .4 Light Level Setting: 1 - 100 fc (10 - 1000 lux)
- .5 Dip Switch Settings
- .6 HVAC dry contacts: (RLY Version only)
- .7 Test Mode: Dip switch setting or programming remote
- .8 Coverage at 9 feet (2.7 m): Maximum 6.5 feet by 33 feet (2 by 10 m) or 214.5 sf (20 sm).
- .6 Networking the wired Spaces
 - .1 Zumwired spaces shall be networked together to enable time clock, load shedding and global management features.
 - .2 The space shall be networked using a ZUMNET RJ45 ports (Ethernet)
 - .3 Networking the space shall incorporate BMS integration as specified hereto after.
- .7 Devices
 - .1 Processor
 - .1 4-Series control system with 2 GB SDRAM and 8 GB flash memory
 - .2 Embedded 4-Series multicore CPU processor
 - .3 iPhone®, iPad®, and Android™ device control app support
 - .4 XPanel computer and web based control
 - .5 Modular programming architecture
 - .6 Onboard IR/serial, COM, I/O, relay, Cresnet® network, and high-speed gigabit Ethernet control ports
 - .7 Control subnet port providing a dedicated local network for Crestron® devices
 - .8 High-speed USB 2.0 host port and rear panel memory card slot
 - .9 Crestron Fusion® software room monitoring and scheduling support
 - .10 Crestron XiO Cloud™ service provisioning and management support
 - .11 Enterprise-class network security and authentication
 - .12 SNMP V3 remote IT management support
 - .13 Native BACnet network/IP support
 - .14 Installer setup via software, web browser, or cloud
 - .15 IPv6 ready
 - .16 Integrates with Apple® HomeKit® technology
 - .17 1 rack unit mounted
 - .18 Product: ZUM-HUB4

Lighting Control System

.8 Product Family: GLEX-FT, GLEP-MLO

.1 Characteristics: GLEX-FT

- .1 Panel shall be digitally addressable using serial or Ethernet communication from Control Processor Panel specified here to after.
- .2 Lighting dimmers shall be compatible with drivers / ballasts and LEDs / lamps as listed in SS26 50 00 LIGHTING.
- .3 Dimmers shall be provided in quantities, control types, and rated for the connected load as shown on the Contract Drawings.
- .4 Line and load phases shall be coordinated per manufacturers recommendations.
- .5 Dimming modules shall be field replaceable.
- .6 Dimming panels shall be listed to UL508.
- .7 Dimming panels shall be listed to UL924.
- .8 Emergency Override: Remote override capability.
- .9 Microprocessor based control for time clock override and remote dimming.
- .10 Lighting control panels shall comply with NEMA PB 1 and UL 50 (CAN/CSA C22.2, No. 94), UL 67 (CSA C22.2, No. 29), UL 489 (CAN/CSA C22.2, No. 65), and UL 916 (CSA C22.2, No. 205).
- .11 No Branch circuit overcurrent protection.
- .12 All SpaceBuilder panels will be UL508 factory assembled.
- .13 Panels may contain 4-series control processor.
 - .1 Product: Crestron DIN-AP4
- .14 Panel may contain 24V power supply
 - .1 Product: Crestron DIN-PWS60
- .15 Panel may contain ethernet to serial converter
 - .1 Product: Crestron DIN-CENCN-2

.2 Control Modules

- .1 GLXX-HDSW8
 - .1 Up to 8 channels of heavy duty modular relays
 - .1 Relays: GLR-HD-1P and GLR-HD-2P
 - .2 Supports 120, 230, 277 & 347 Volt applications
 - .2 Requires 24 Volts DC, delivered via 16 pin GLXX-CTRL
- .2 GLXX-HDSW16
 - .1 Up to 8 channels of heavy duty modular relays
 - .1 Relays: GLR-HD-1P and GLR-HD-2P

Lighting Control System

- .2 Supports 120, 230, 277 & 347 Volt applications
- .2 Requires 24 Volts DC, delivered via 16 pin GLXX-CTRL
- .3 Enclosures GLEX-FT
 - .1 GLEX-FT-24
 - .1 16AWG Galvanized steel backbox. Surface Mount.
 - .2 Height: 124.25 in (616 mm)
 - .3 Width: 16.13 in (409 mm)
 - .4 Depth: 4.44 in (113 mm)
 - .5 120-277 VAC.
 - .2 GLEX-FT-56
 - .1 16AWG Galvanized steel backbox
 - .2 Height: 39.66 in (1007 mm)
 - .3 Width: 16.13 in (409 mm)
 - .4 Depth: 4.44 in (113 mm)
 - .5 120-277 VAC.
 - .3 GLEX-FT-84-HC
 - .1 16AWG Galvanized steel backbox
 - .2 Height: 63 in (1600.2 mm)
 - .3 Width: 15.25 in (387.35mm)
 - .4 Depth: 4.5 in (114.3 mm)
 - .5 120-277 VAC.

2.4 User Interfaces

- .1 Product: Crestron C2N-CBD-P-W [B][A]-S
 - 1. Provide keypad quantities and locations as specified herein and shown on the contract drawings.
 - 2. Field configurable remote keypad with auto-adjusting backlight illuminating replaceable, engravable programmable buttons in number indicated, with white LED indicators, configured to fit in standard single-gang box.
 - 3. Trimmed using decorator style faceplate (not included) or Crestron decorator-style faceplates (FP-G series)
 - 4. Cresnet connected for power and communication
 - 5. Minimum Buttons: 2, Maximum Buttons: 8.
 - 6. Color shall be White [black][almond].
 - 7. Mounting: Mounts in a 1-gang or larger electrical box or mud ring

Lighting Control System

2.5 Faceplates

.1 Faceplates:

1. keypad devices Provide decorator faceplates for all keypad devices.
2. Multiple devices adjacent to door jams shall be ganged together.
3. Decorator faceplates shall be white and shall match in texture and color of the
4. Products:
 - .1 FP-G1-W [B][A]-S
 - .2 FP-G2-W [B][A]-S
 - .3 FP-G3-W [B][A]-S
 - .4 FP-G4-W [B][A]-S

.2 Touch Screens

- .1 Widescreen active-matrix color display
 - .1 TSW-1070: 1920 x 1200 WUXGA display resolution
 - .2 TSW-770: 1280 x 800 WXGA display resolution
 - .3 TSW-570: 280 x 720 HD 720 display resolution
 - .4 TSW-570P: 720 x 1280 HD 720 display resolution
- .2 Capacitive touch screen display
- .3 Custom-programmable virtual control buttons
- .4 Supports Crestron HTML5 and Smart Graphics® software custom user projects
- .5 Built-in Rava® SIP intercom
- .6 Built-in speakers and microphone
- .7 H.265, H.264, or MJPEG streaming video display
- .8 Native apps for Crestron Home™ OS, Sonos® home sound control, Zoom Rooms™ conferencing control, Microsoft Teams® online meeting solution, and various room scheduling services
- .9 Built-in Bluetooth® communications beacon
- .10 Built-in web browsing
- .11 Single wire Ethernet connection with PoE or PoE+ power
- .12 Wi-Fi® network connectivity (only available on 1070 and 770 models)
- .13 Dual USB 2.0 ports for room availability accessories
- .14 Enterprise grade security and authentication
- .15 Web, cloud, or device-based configuration

Lighting Control System

- .16 Electrical box mounting with provided mounting bracket Color: [Black] [White]. Mountable with a 1-3 gang mounting box
- .17 Products
 - .1 Crestron TSW-770-W-S (7" white, 2-gang mounted)
 - .2 Crestron TSW-1070-W-S (10" white, 3-gang mounted)
 - .3 Crestron TSW-570P-W-S (5" white, 1-gang mounted)
 - .4 Crestron TSW-770-B-S (7" black, 2-gang mounted)
 - .5 Crestron TSW-1070-B-S (10" black, 3-gang mounted)
 - .6 Crestron TSW-570P-B-S (5" black, 1-gang mounted)
- .3 XPANEL Interface: Virtual Touch Screen
 - .1 Touch screen user interface, network-connected lighting management interface running on Crestron lighting control processor to provide lighting control, daylight harvesting, occupancy sensing, lighting schedules and overall adjustment to system functionality
 - .2 Virtual touch screen is to be accessible via computer or laptop interface furnished by other.
 - .3 Access to XPanel shall be via browser-based IP address or .EXE file application.
 - .4 Product: Crestron XPANEL

PART 3 - EXECUTION

3.1 Dual-Technology Motion Sensors

- .1 Product: Steinel GLA-DT-QUATTRO-COM1[2]-24
 - 1. Characteristics
 - .1 Sensing Technology: Passive infrared (PIR), single pyro, 11 detection levels, 520 switching zones, ultrasonic 40 kHz.
 - .2 Mounts to a 4" octagon box.
 - .3 Time Delay Setting
 - .4 Light Level Setting: 1 - 100 fc (10 - 1000 lux)
 - .5 Dip Switch Settings
 - .6 HVAC dry contacts: (COM2 Version only)
 - .7 Test Mode: Dip switch setting or programming remote
 - .8 Ultrasonic Coverage at 9 feet (2.7 m):
 - .1 Presence: Maximum 20 feet by 20 feet (6 by 6 m) or 400 sf (36 sm).

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- .2 Radially and Tangentially: Maximum 32 feet by 32 feet (10 by 10 m) or 1,000 sf (100 sm).
- .9 PIR Detection Zones:
 - .1 Presence: Maximum 10 feet by 10 feet (3 by 3 m) or 100 sf (9 sm).
 - .2 Radially: Maximum 13 feet by 13 feet (4 by 4 m).
 - .3 Tangentially: Maximum 26 feet by 26 feet (8 by 8 m).
- .2 Product: Steinel GLA-DT-CM-COM1-24
 - .1 Characteristics
 - .1 Sensing Technology: Passive infrared (PIR), single pyro, 11 detection levels, 520 switching zones, ultrasonic 40 kHz
 - .2 Mounting:
 - .1 Direct to the wall or ceiling with anchor bolts
 - .2 Ceiling mounted with 1/2 inch snap in chase nipple, washer and lock nut. Time Delay Setting
 - .3 Light Level Setting: 1 - 100 fc (10 - 1000 lux)
 - .4 Dip Switch Settings
 - .5 Test Mode: Dip switch setting or programming remote
 - .6 Ultrasonic Coverage at 9 feet (2.7 m):
 - .1 Presence: Maximum 22 feet (7 m) or 426 sf (130 sm).
 - .2 Radially: Maximum 38 feet (11.5 m) or 1,236 sf (376 sm).
 - .3 Tangentially: Maximum 26 feet (8 m) or 718 sf (218 sm).
 - .7 PIR Detection Zones:
 - .1 Presence: Maximum 22 feet (7 m) or 440 sf (134 sm).
 - .2 Radially: Maximum 26 feet (8 m) or 655 sf (200 sm).
 - .3 Tangentially: Maximum 82 feet (25 m) or 5290 sf (1612 sm).
 - .3 PIR Motion Sensors
 - .1 Product: Steinel GLA-IR-QUATTRO-HD-COM1[2]-24
 - .1 Characteristics
 - .1 Sensing Technology: Passive infrared (PIR)
 - .2 Mounts to a 4" octagon box.
 - .3 Delay Setting
 - .4 Light Level Setting: 1 - 100 fc (10 - 1000 lux)
 - .5 Dip Switch Settings
 - .6 HVAC dry contacts: (COM2 Version only)

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- .7 Test Mode: Dip switch setting or programming remote
- .8 Coverage at 9 feet (2.7 m): 360 deg square mechanically scalable detection zones.
 - .1 Presence: Maximum 25.5 feet by 25.5 feet (7.9 by 7.9 m) or 650.25 sf (62.4 sm).
 - .2 Radially: Maximum 25.5 feet by 25.5 feet (7.9 by 7.9 m) or 650.25 sf (62.4 sm).
 - .3 Tangentially: Maximum 65.5 feet by 65.5 feet (20 by 20 m) or 4,290.25 sf (400 sm).
- .4 Ultra Sonic Motion Sensors
 - .1 Product: Steinel GLA-US-HALLWAY-COM1[2]-24
 - .1 Characteristics
 - .1 Sensing Technology: Ultrasonic
 - .2 Mounts to a 4" octagon box.
 - .3 Delay Setting
 - .4 Light Level Setting: 1 - 100 fc (10 - 1000 lux)
 - .5 Dip Switch Settings
 - .6 HVAC dry contacts: (COM2 Version only)
 - .7 Test Mode: Dip switch setting or programming remote
 - .8 Coverage at 9 feet (2.7 m): Maximum 6.5 feet by 65 feet (2 by 20 m) or 422.5 sf (40 sm).
 - .2 Product: Steinel GLA-US-ONEWAY-COM1-24
 - .1 Characteristics
 - .1 Sensing Technology: Ultrasonic
 - .2 Mounts to a 4" octagon box.
 - .3 Delay Setting
 - .4 Light Level Setting: 1 - 100 fc (10 - 1000 lux)
 - .5 Dip Switch Settings
 - .6 Test Mode: Dip switch setting or programming remote
 - .7 Coverage at 9 feet (2.7 m): Maximum 6.5 feet by 33 feet (2 by 10 m) or 214.5 sf (20 sm).

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3.2 Daylight Sensors

- .1 Indoor Daylight Sensor (Open/Closed loop)
 - .1 Open Loop Function
 - .1 Continually monitors daylight entering window or skylight to enable daylight harvesting applications to provide control of room lighting based on presence of daylight.
 - .2 Light sensitivity sliders:
 - .1 OL: 3-300 foot-candles (factory setting)
 - .2 OL: 30-3000 foot-candles
 - .3 OL: 60-6000 foot-candles
 - .3 Center Axis OL:90°
 - .2 Closed Loop Function
 - .1 Continually monitors daylight at work station location to enable daylight harvesting or lumen maintenance applications to provide control of room lighting based on lighting level at workstation.
 - .2 Light sensitivity slider:
 - .1 CL: 3 to 300 foot-candles
 - .3 Center Axis CL:45°
 - .3 Equipped with 3-wire interface for direct connection to control system utilizing control processor; 24 VDC power from network control bus.
 - .4 Mounting: Surface or flush ceiling mount directly to drywall or drop-tile
 - .5 Product: Crestron GLA-LDL-PC-0-10
- .2 Outdoor Daylight and Color Temperature Sensor
 - .1 Measures true color temperature and intensity of natural sunlight.
 - .2 Communicates over serial to control system to match indoor lighting with the outdoors.
 - .3 Outdoor rated for rooftop installation.
 - .4 IP67 for watertight operation.
 - .5 CCT of 2,000K to 25,000K.
 - .6 0 to 100,000 lux.
 - .7 360 degree semispherical.
 - .8 Product: GLS-LCCT
- .3 Partition Sensors
 - .1 Single sided diffuse reflective sensing technology.
 - .2 Digital device with control bus connectivity.

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- .3 Surface mounted to 1-gang back box.
- .4 Trim using decorator face plate to match mounting surface.
- .5 Product: Crestron GLS-PART-CN
- .4 Sensor Interface Module
 - .1 Sensor Interface Device: Integrates occupancy sensors and related sensors with control network. In separate enclosure. 4-wire bus providing 24 VDC power to network devices, with two independent sensing inputs.
 - .2 Product: Crestron GLS-SIM

3.3 Control Processor Panel and Distribution Panels (Optional)

- .1 Control processor Panels shall be provided in quantities and locations per the contract drawings, or as required for a fully networked lighting control system.
- .2 Control processor panels shall be factory assembled in a UL508 Panel shop
- .3 Shall include the following equipment to support lighting control devices
 - .1 Cabinets
 - .1 Made of 16AWG galvanized steel
 - .2 NEMA 1 rated
 - .3 Product: DIN-EN
 - .2 Processors
 - .1 Crestron 4-series control system
 - .2 Modular architecture supports multiple simultaneous running programs.
 - .3 Ethernet 10/100Base-T and Cresnet Connected
 - .4 Astronomical time clock with events stored in non-volatile RAM
 - .5 Native BACnet/IP with support for up to 500 BACnet objects
 - .6 Built-In Web Server: IIS v.6.0
 - .7 SNMP remote management.
 - .8 Active Directory support.
 - .9 IPv6 ready.
 - .10 DHCP and DNS Support
 - .11 Native Email Client
 - .12 Remote Diagnostics
 - .13 Remote Program Loading and Administration
 - .14 SSL security plug in
 - .15 Support user assigned or dynamic IP address.

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- .16 Product: Crestron DIN-AP4
- .3 Power Supplies
 - .1 Provide regulated 24 VDC power supplies as required to support lighting control equipment
 - .2 120 VAC input
 - .3 Product: Crestron DIN-PWS60
- .4 Cresnet to Ethernet Bridge
 - .1 24v DC Input
 - .2 IEEE 802.3 Power of ethernet connection.
 - .3 Serial communication
 - .4 USB 2.0 for setup.
 - .5 Product: DIN-CENCN-2-POE
- .5 Ethernet Distribution
 - .1 48V DC Input, 100-240 VAC 50/60 Hz Supply
 - .2 (5) [16] IEEE 802.3 Ethernet Ports
 - .3 32 to 104 degrees Fahrenheit
- .6 Floor Hub
 - .1 Connects up to 200 Crestron ZUMMESH-NETBRIDGE devices.
 - .2 Contain astronomical time clock.
 - .3 Maintenance is performed via standard web browser.
 - .4 1 rack unit mounted
 - .5 Product: Crestron ZUM-HUB4
- .7 ZUML-HUB4-PAK
 - .1 Enclosure: DIN-EN-3X18
 - .1 16AWG Galvanized steel backbox
 - .2 120 Volts AC, 60 Hz
 - .3 Height: 23.50 in (597 mm)
 - .4 Width: 14.38 in (366 mm)
 - .5 Depth: 4.44 in (113 mm)
 - .6 DIN Rail Detail: (3) 342 mm x 35 mm rails
- .8 CLP-HUB-SW-POE-5
 - .1 Enclosure: DIN-EN-2X18
 - .1 16AWG Galvanized steel backbox

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- .2 120 Volts AC, 60 Hz
- .3 Height: 12.32 in (323 mm)
- .4 Width: 14.13 in (359 mm)
- .5 Depth: 4.38 in (111 mm)
- .6 DIN Rail Detail: (2) 342 mm x 35 mm rails
- .9 CLP-HUB-SW-POE-10
 - .1 Enclosure: DIN-EN-2X18
 - .1 16AWG Galvanized steel backbox
 - .2 120 Volts AC, 60 Hz
 - .3 Height: 23.50 in (597 mm)
 - .4 Width: 14.38 in (366 mm)
 - .5 Depth: 4.44 in (113 mm)
 - .6 DIN Rail Detail: (3) 342 mm x 35 mm rails

3.4 UL924 Emergency Override

- .1 Phase Loss Sensor
 - .1 Lighting control panels shown on the contract drawings as emergency life safety shall contain UL924 listed modules and OVR inputs.
 - .2 Provide phase loss sensor with sense for all 3 phases.
 - .3 Upon loss of any of the 3 phases, the phase loss sensor shall trigger the emergency life safety panel's override port(s).
 - .4 Product: Crestron GLS-PLS-120/277.
- .2 Bypass Relays
 - .1 Switched and 2-wire dimmed loads
 - .1 The UL924 listed 2-wire Emergency Shunt Relay shall allow emergency power to go around the control device to bring emergency power to the load.
 - .2 Product: GLA-ESR
- .3 Automatic Load Control Relays (ALCR)
 - .1 Switched Loads
 - .1 UL924 listed 2-wire automatic load control relay shall bring emergency life safety lights on to 100% upon loss of power
 - .2 Upon the loss of normal power, the ALCR shall bypass the control device allowing emergency power to access the loads regardless of switch position.
 - .3 Products:
 - .1 Crestron GLA-EPC-PM

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.2 Crestron GLA-EPC-2

.2 4-Wire dimming loads

- .1 UL924 listed 4-wire automatic load control relay shall bring emergency life safety lights on to 100% upon loss of power
- .2 Upon the loss of normal power, the ALCR shall bypass the control device allowing emergency power to access the load regardless of switch position.
- .3 The ALCR shall contain a normally open relay to open the control wires allowing the lights to come to full bright.
- .4 The ALCR shall allow for integration with fire alarm.
- .5 Product: Crestron GLA-EPC-FLV

3.5 Programming and Configuration Software

- .1 Lighting system configuration software shall allow custom programming for lighting control system.
- .2 Lighting system configuration software shall generate custom software control interface modules for communication with compatible remote integrated systems.
- .3 The lighting system configuration software shall be GUI based for programming and development.
- .4 The custom software control interface shall include the following control data:
 - .1 Complete lighting system control functions.
 - .2 System specific control sets for sub systems and supervisory systems
 - .3 Bidirectional digital and analog data communication.
 - .4 Bidirectional serial data communication.

3.6 Conductors and Cabling

- .1 Power Supply Side of Remote-Control Power Sources: Comply with requirements of Division 26 Section "Low-Voltage Electrical Power Conductors."
- .2 UTP Cable: 100-ohm, UTP. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
- .3 Communications Control Cable, Non-Plenum Rated: 22 AWG data pair stranded bare copper, and 18 AWG power pair stranded bare copper, Type CM.
 - .1 Product: Crestron CRESNET-NP.
- .4 Communications Control Cable Plenum Rated: 22 AWG data pair, stranded bare copper and 18 AWG power pair, stranded bare copper, Type CMP, complying with NFPA 262.
 - .2 Product: Crestron CRESNET-P.

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3.7 Fixture Testing

- .1 Contractor shall provide lighting control factory test reports for each fixture specified on this project
- .2 Test report shall include
 - .1 Confirmation of compatibility with control device
 - .2 Dimming Range
 - .3 Performance notations

3.8 Engraving

- .1 Keypad buttons shall be factory engraved using laser technology
- .2 Initial shipment of keypads shall be factory engraved per the sequence of operations specified herein and shown on the contract documents
- .3 Custom keypad engravings shall be provided as part of the close out procedures.

3.9 BMS Integration

- .1 The lighting control system shall be integrated with the BMS system as specified in DIV. 25.
- .2 Communication shall occur using BACNET/IP Protocol.
- .3 Contractor shall provide licenses for each of the following objects and shared amongst the BMS system
 - .1 Occupancy Status
 - .2 Zone On/Off/Dim
 - .3 Photocell reading
- .4 The lighting control system shall also accept time clocked events from the BMS system
- .5 Provide necessary coordination labor for integration of all BACNET objects listed.

3.10 AV Integration

- .1 The lighting control system shall be integrated with the AV solutions as specified in DIV.26
- .2 The lighting and AV systems shall interface via Ethernet communication or RS232.
- .3 Contractor shall provide ethernet drops as required for the lighting control system to connect to the AV system.
- .4 The following objects shall be shared with the AV system:
 - .1 Occupancy Status
 - .2 Zone On/Off/Dim
 - .3 Photocell reading
 - .4 Scene preset recalls

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- .5 Provide necessary coordination labor for integration of all AV objects listed hereto before.

3.11 System Functions and Sequences

- .1 The system shall be capable of the following lighting control functions:
 - .1 Scene Creation: Store levels of selected fixture circuits in preset groups.
 - .2 Scene Recall: recall previous stored scenes.
 - .3 All zones off
 - .4 Raise/lower level of all zones
 - .5 Password entry for touchscreen access
 - .6 Room/Zone selection
 - .7 Raise/lower room shades
 - .8 Schedule events to be automatically recalled

User Interface Control Functions

- .2 The keypad interface shall be capable of the following system control functions:
 - .1 Scene Recall
 - .2 Raise/Lower
 - .3 Off
- .3 Touchscreen and Virtual touch screen interfaces shall be capable of the following system control functions:
 - .1 Password Entry
 - .2 Multiple levels
 - .3 Room/Zone selection
 - .4 Scene Recall
 - .5 Raise/Lower
 - .6 Shade Control
 - .7 Timeclock Events
 - .8 Customer logo and color scheme
- .4 Optional control sequences for advanced control:
 - .1 Occupancy adjustments
 - .2 Sensor Timeout
 - .3 Control logic (occupancy or vacancy)
 - .4 Lighting Scenes
 - .5 Individual zone control override
 - .6 Timeclock adjustments

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- .7 Modify timeclock activation schedule
- .8 Select/unselect pre-programmed timeclock events
- .9 Display all timeclock events
- .10 Daylight Harvesting Adjustments
- .11 Low end trim
- .12 Response time
- .13 Zone control
- .14 Scene Recall
- .15 Fade time
- .16 Color scene recall

3.12 Time Clock Events

- .1 The lighting control system shall have astronomical time clocked events. 6-time clock events shall be provided.
- .2 End user shall have the option to create additional time clock events via touch screen or X-PANEL interfaces.

3.13 Installation

- .1 Prior to installation, examine work area to verify measurements, and that commencing installation complies with manufacturer's requirements.
- .2 Comply with requirements of Division 26 Sections "Common Work Results for Electrical."
- .3 Do not install network power controls until space is enclosed, HVAC systems are running, and overhead and wet work in space are complete.
- .4 Install network power switching controls in accordance with manufacturer's instructions.
- .5 Grounding: Provide electrical grounding in accordance with NFPA 70.

3.14 Manufacturer Supported Devices

- .1 Pre-wire
 - .1 Manufacturer trained and authorized personnel shall provide on-site visit during the rough-in stage of the installation. At this time wiring topologies and terminations shall be reviewed with the Contractor.
- .2 Startup
 - .1 Provide manufacturer's certified system startup and adjustment.
 - .2 Switch each load on and off with manual line test feature of the power switching module before installing processors.
 - .3 Perform operational testing to verify compliance with Specifications. Adjust as required.

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.3 Training

- .1 Within 30 days, Factory authorized service representative to instruct owner's staff to adjust, operate and maintain network power switching systems; and provide instruction using the system software.
- .2 Demonstration: Schedule demonstration with Owner.
- .3 Training: Train Owner's personnel to operate, maintain, and program network power switching systems.
- .4 Furnish set of approved submittals, and record drawings of actual installation for Owner's personnel in attendance at training session.

END OF SECTION

Fire Alarm System

PART 1 - GENERAL

1.1 General Requirements

- .1 The General Conditions of CCDC 2 and the General Requirements of Division 1, form part of this section, and must be read in conjunction with the requirements of this section, and all related sections.
- .2 Comply with section 260100 – Electrical General Requirements.
- .3 Provide labour, materials, and equipment for installation, testing, and commissioning of a complete operating fire alarm system as specified herein, indicated on Drawings, add/or required otherwise. The system shall be left ready for continuous and efficient satisfactory operation.

1.2 References

- .1 Comply with the requirements of latest edition of the following standards:
 - .1 CAN/ULC-S524, Standard for the installation of Fire Alarm Systems.
 - .2 ULC/S525, Audible Signal Appliances for Fire Alarm Systems.
 - .3 CAN/ULC-S526, Visual Signal Appliances for Fire Alarm Systems.
 - .4 CAN/ULC-S527, Control Units for Fire Alarm Systems.
 - .5 CAN/ULC-S528, Manual Pull Stations for Fire Alarm Systems.
 - .6 CAN/ULC-S529, Smoke Detectors for Fire Alarm Systems.
 - .7 CAN/ULC-S530, Heat Actuated Fire Detectors for Fire Alarm Systems.
 - .8 CAN/ULC-S531 Smoke Alarms for Fire Alarm Systems.
 - .9 CAN/ULC-S533, Egress Door Security and Releasing Devices.
 - .10 CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems
 - .11 CAN/ULC-S537, Standard for the Verification of Fire Alarm System Installations
 - .12 CAN/ULC-S541 – Speakers for Fire Alarm Systems
 - .13 CAN/ULC-S553 - Installation for Smoke Alarms

1.3 Submittals

- .1 Submit Shop Drawings in accordance with section 260100. Shop Drawing shall include:
 - .1 Complete system riser diagram showing all devices, control equipment, circuits and wiring.
 - .2 Details of system operating sequence.

Fire Alarm System

- .3 Details and performance specifications for system control annunciation and peripherals.
- .4 Details for devices.
- .2 Submit arrangement and wording of annunciators for fire alarm zone indications to local fire department and provide changes as requested. Submit document to local fire department to department's requirement.
- .3 Following completion of verification, and of acceptance of the installation by local fire department, submit the certification of the Fire Alarm system, together with detailed verification record sheets showing location of each device and all verification results.
- .4 Submit the operating and maintenance manual in accordance with section 260100, the manual shall include:
 - .1 Instructions for the operation of the fire alarm system.
 - .2 Instructions for the maintenance of the fire alarm system.
 - .3 Approved shop drawings with all the connections.

1.4 Qualifications

- .1 Acceptable Manufacturers:
 - .1 Simplex
 - .2 ChubbEdwards
 - .3 Notifier
 - .4 Mircom
- .2 Installer shall be Certified fire alarm installer by the respective manufacturer.

PART 2 - PRODUCTS

2.1 System Description

- .1 The fire alarm system shall be an OBC, single stage, zoned non-coded, fully addressable, microprocessor based, electrically supervised system with all components listed by ULC and CSA.
- .2 The fire alarm system shall include, but not limit to:
 - .1 Fire alarm control panel (FACP).
 - .2 Initiating devices: Manual pull station, automatic smoke and heat detectors.
 - .3 Signal devices: audible and visual.
 - .4 Auxiliary devices.
 - .5 Initiating circuits, signal circuits (minimum two circuits) and auxiliary circuits.

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- .6 Power and circuit wiring.
- .3 System shall be electrically supervised in accordance with CAN/ULC S524.
- .4 Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory. System shall be capable of storing dual configuration programs with one active and one in reserve. Panel shall be capable of full system operation during a new configuration download. To accommodate this capability, the download of a new Panel program will be transferred to a "secondary" configuration memory bank, while the Panel continues to function on the "primary" configuration memory bank.
- .5 History Logs: The system shall provide a means to recall alarms, supervisory and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.
- .6 Priority of Signals: Fire alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.
- .7 Non-interfering: An event on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACP after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent addressable device activations.
- .8 A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.
- .9 FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values. The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations. The FACP shall automatically indicate when an individual sensor needs cleaning.

2.2 System Operation

- .1 Activation of any alarm initiating devices (sprinkler flow switch, manual pull station, heat detector, smoke detector, etc.) shall initiate the operations to occur as follows:
 - .1 All the audible signal devices sound the alarm tone throughout the building. All the visual signal devices shall be activated.
 - .2 The zone of initiation device shall be displayed on the control panel and remote annunciator.

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- .3 Central station shall be signaled automatically for the notification of fire department.
- .4 Release door hold open devices.
- .5 Transmit signals to enable the following functions:
 - .1 Fans shut down
 - .2 Pressurization fans start-up.
 - .3 Fire doors and/or smoke control doors, to close and/or open.
 - .4 Elevators to commence the fire mode sequence.
 - .5 Independent fire suspension systems to commence the fire mode sequence.
 - .6 Other functions as required on the Drawings.
- .2 After one (1) minute of alarm, the system could be manually silenced via the silencing switch on the control panel. A subsequent alarm shall re-activated signals.
- .3 The alarm condition shall be cleared only upon activation of the reset switch on the control panel.
- .4 Activation of supervised sprinkler devices or other auxiliary systems, i.e. supervisory valves, pressure switches, fire pump, generator supervised contacts, etc. shall initiate the following operations:
 - .1 The respective supervisory zone shall be displayed on the control panel and remote annunciator.
 - .2 Activate an audible signal (steady tone) on control panel and remote annunciator. The signal may be silenced via silencing switch on control panel.
 - .3 Activate a visual signal (indicator) on control panel.
 - .4 Transmit a general trouble signal to central station.
 - .5 The trouble condition shall be cleared only via reset switch.
- .5 Any open circuit, circuit ground fault, short circuit condition, circuit loss of power, loss of main system power, system standby power trouble and removal of any system component shall initiate the following system trouble condition operations:
 - .1 The respective supervisory zone shall be displayed on the control panel.
 - .2 Activate the system trouble indicator on control panel and remote annunciator.
 - .3 Activate system trouble audible signal (steady tone) on control panel and annunciator. The signals may be silenced via silencing switch on control panel.
 - .4 Transmit a general trouble signal to central station.
 - .5 The trouble condition shall be cleared when the cause is rectified.

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2.3 Fire Alarm Control Panel

- .1 Fire alarm control panel (FACP) shall provide power, annunciation, supervision and control for the system.
- .2 Recessed or semi-recessed sprinkler-proof enclosure with lockable hinged front door.
- .3 Alarm initiating circuits in accordance with the number of zone indicated on the Fire Alarm Schedules plus 20% spare space capacity for future expansion and for the quantity of field devices in accordance with the manufacturer's recommendations.
- .4 Minimum two (2) signal circuits in accordance with the manufacturer's recommendations, with provision for future signal circuits. Signal circuits shall not be loaded more than 80% in order to allow for future adjustment.
- .5 High intensity LEDs for each zone circuit with 20% spare capacity for future zones as indicated. Type labels per the Fire Alarm Schedule and to the requirements of authorities having jurisdiction.
- .6 Common control module with LCD or LED backlit two-line character display of system function with the following additional features:
 - .1 Trouble LED, buzzer, silence switch. 'Signals Silenced' LED.
 - .2 'Power-On', 'Disable', 'Supervisory; and 'Alarm' LEDs.
 - .3 'Ground Fault' and 'Loss of Normal Power' LED.
 - .4 Test pushbutton.
 - .5 Alarm reset buttons.
- .7 Individual trouble display for each detection and signal circuit.
- .8 Auxiliary or output point for:
 - .1 Signal to motor controls for fan system shut-down or smoke control operations. Relays shall have contacts rated at 15 amps, pilot duty. Provide control measure to manually operate (turn on and turn off) each motor from FACP.
 - .2 Transmission of signal to off-premises central monitoring station. Actual connection for this function will be the Owner.
 - .3 Signals to elevator controllers.
 - .4 Signals to maglock release and hold open devices.
 - .5 Transmission of signal to security system for F.A. monitoring.
 - .6 Other functions as required on the drawings.
 - .7 20% spare output points for future.
- .9 Operator interface keypad. Provide LCD display with wording to Consultant's approval in accordance with Fire Alarm Schedule.

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- .10 Coded terminal strips for external connections to signal circuits, initiating circuit, multiplex annunciators, etc.
- .11 Receipt of a signal from an alarm initiating device shall cause audible signals to sound for a full period whether or not a previous alarm has been silenced manually.
- .12 The necessary controls to ensure that a fire alarm signal is not initiated during under-voltage or over-voltage conditions caused by changeover from normal to emergency power supply and vice versa.
- .13 Provide the necessary hardware and software required to provide a proper system operation.
- .14 Provide main system power supply to operate the entire fire alarm system and power supply at 24 volts from a 120 VAC 60Hz input. The integral standby power shall consist of 24 volt dc sealed nickel-cadmium batteries or gell-cell batteries, automatic battery charger with power reversal protection, ammeter and voltmeter to monitor charge rate and battery voltage. Standby power requirements shall be in accordance with CAN/ULC-S524, Section 3.2, Power Supply. Battery capacity shall be sufficient to provide 24-hour supervision plus 60 minutes full alarm operation. Battery charger shall be capable of recharging batteries to 80% capacity in 24 hours.

2.4 System Devices

- .1 Manual Pull Stations
 - .1 Manual pull stations shall be single stage, extruded aluminum, semi-flush or surface, red, pull activated, wall mounted in 102mm square Red box.
 - .2 Provide tamper proof, weatherproof clear shield complete with a battery operated warning horn.
- .2 Heat Detectors
 - .1 Combination of fixed 57°C (135°F) and 8.3°C (15°F)/min rate-of-rise type, in all areas except where normal temperature fluctuations exceed 10°C (18°F)/min.
 - .2 Fixed temperature 91°C (195°F) type, provided in areas with normal ambient temperature between 38°C (100°F) and 66°C (150°F).
 - .3 Ceiling mounted in 102 square outlet box.
 - .4 Detector in elevator shaft to be complete with auxiliary relays and wired to elevator controller.
- .3 Area Smoke Detectors
 - .1 Photoelectric type ceiling smoke detector with the following features:
 - .1 Sensitivity read-out;
 - .2 Snap-in base;
 - .3 Visual indication of detector actuation.

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- .2 Ceiling mounted in 102mm square outlet box.
- .3 Smoke detectors in elevator machine rooms, elevator lobbies of 1st floor, P1 level and 2nd floor, and elsewhere indicated shall be provided with auxiliary relays, and wired to elevator controls for supplementary operation of elevators.
- .4 Smoke detectors required for door hold openers and fire automatic doors shall be provided with auxiliary relays, and wired to door hold openers.
- .4 Duct-Mounted Smoke Detectors
 - .1 Product Description: photoelectric type with the following features:
 - .1 Auxiliary SPDT relay contact for locate fan shutdown;
 - .2 Key-operated normal-reset-test switch.
 - .3 Duct sampling tubes extending width of duct.
 - .4 Visual indication of detector actuation.
 - .5 Duct-mounted housing.
 - .6 Powered from fire alarm control panel.
 - .2 Provide remote alarm indication for duct mounted smoke detectors installed in concealed spaces. Ensure that all detectors are accessible for maintenance.
 - .3 Refer to Mechanical Drawings for duct sizes and air velocities to ensure that the proper quantity of detectors is provided to adequately monitor the cross-sectional area of the duct in accordance with manufacturer's recommendations. Co-ordinate the proper location and installation with Division 23.
 - .4 Where duct-mounted smoke detectors are installed outdoors, provide weather-proof enclosure. Provide heater and power and manufacturer's instruction.
 - .5 Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct sensor shall be provided by the FACP.
 - .6 Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
- .5 Addressable Circuit Interface Modules
 - .1 Addressable Circuit Interface Modules: Modules shall be used for monitoring of non-addressable devices and/or circuit, and for control of evacuation indicating appliances and AHU systems.
 - .2 Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signalling line or a separate two-wire pair running from an appropriate power supply as required.

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- .3 There shall be the following types of modules:
 - .1 Type 1: Monitor Circuit Interface Module:
 - .1 For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. The supervision of the zone wiring will be Class B. This module will communicate status (normal, alarm, trouble) to the FACP.
 - .2 For conventional 4-wire smoke detector with Class B wiring supervision. The module will provide detector reset capability and over-current power protection for the 4-wire detector. This module will communicate status (normal, alarm, trouble) to the FACP.
 - .2 Type 2: Line Powered Monitor Circuit Interface Module
 - .1 This type of module is an individually addressable module that has both its power and its communications supplied by the two wire multiplexing signaling line circuit. It provides location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall have the capability of communicating four zone status conditions (normal, alarm, current limited, trouble) to the FACP.
 - .2 This module shall provide location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices. The module shall communicate four zone status conditions (open, normal, abnormal, and short). The two-wire signaling line circuit shall supply power and communications to the module.
 - .3 Type 3: Single Address Multi-Point Interface Modules
 - .1 This multipoint module shall provide location specific addressability for four initiating circuits and control two output relays from a single address. Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of communicating four zone status conditions (normal, open, current limited, and short). The input circuits and output relay operation shall be controlled independently and disabled separately.
 - .2 This dual point module shall provide a supervised multi-state input and a relay output, using a single address. The input shall provide supervised monitoring of two normally open, dry contacts with a single point and be capable of communicating four zone status conditions (normal, open, current limited, and short). The two-wire signaling line circuit shall supply power and communications to the module.
 - .3 This dual point module shall monitor an unsupervised normally open, dry contact with one point and control an output relay with the other point, using a single address. The two-wire signaling line circuit shall supply power and communications to the module.

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- .4 Type 4: Line Powered Control Circuit Interface Module
 - .1 This module shall provide control and status tracking of a Form "C" contact. The two-wire signaling line circuit shall supply power and communications to the module.
- .5 Type 5: 4-20 mA Analog Monitor Circuit Interface Module
 - .1 This module shall communicate the status of a compatible 4-20 mA sensor to the FACP. The FACP shall annunciate up to three threshold levels, each with custom action message; display and archive actual sensor analog levels; and permit sensor calibration date recording.
 - .6 All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.
- .6 End-of-Line Devices
 - .1 Mount end of line devices in box with last device or separate box wall mounted, adjacent to last device.
- .7 Horns:
 - .1 Temporal horns rated at 98 dba to 91dba at 3m, finished in white and operated on 24V DC. Mounted in 102mm square or single gang outlet box. High and Low field selectable sound output level setting.
- .8 Fire Alarm Strobe
 - .1 Provide surface wall mounted synchronized high strobe lights to indicate alarm condition.
 - .2 The strobe light shall consist of a xenon tube with red lens. 75cd to 110 cd flash intensity.
 - .3 Mounted in 102mm square or single gang outlet box.
- .9 Remote annunciator
 - .1 Annunciators shall contain necessary number of LED lights and LCD to displace all alarm, trouble and control zones. Annunciators shall be flush-mounted with brushed aluminum metal work and trim.
 - .2 The annunciator shall contain a lamp test switch, trouble buzzer, acknowledge push button, signal silencing push button and reset push button.

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.10 Passive Graphic

- .1 Passive Graphic to be white back ground with color lines and text. Show all F/A zone areas, stair and elevator shafts, interior walls and doors and sprinkler devices. Size graphic as required. Brushed aluminum trim with tempered glass front. Install passive graphic beside each annunciator.

.11 Hold Open Devices

- .1 Furnish and install where shown on the Drawings, magnetic door holders designed for positive release to secure openings as indicated for limiting smoke spread. The units furnished shall be brushed aluminum finish, compatible with the door as listed in the door schedule as follows:
 - .1 24VDC concealed wiring with 25lb holding force.
 - .2 24VDC surface wiring with 25lb holding force.
 - .3 24VDC recessed door with 25lb holding force.
 - .4 24VDC floor mounting, single door with 25 lb holding force.
 - .5 24VDC floor mounting, double door with 25lb holding force.
 - .6 24VDC sliding door with 120lb holding force, grey hammer-tone finish.
 - .7 24VDC overhead with 120lb holding force, grey hammer-tone finish.

2.5 Wiring

- .1 Install all wiring in conduit.
- .2 Fire alarm system wiring shall be run in separate conduit.
- .3 Provide shielded wiring when recommended by the manufacturer's specifications.
- .4 Wires shall be CSA-FAS Type 105 copper conductor, 105°C rating, not less than 300V. Wiring shall be sized not less than requirement of Section 32-100 of the Electrical Safety Code, Class 1 or Class 2 circuits as required, with screw-terminal wiring connections.
- .5 Stranded conductors with more than 7 strands shall be bunched-tinned or terminated in compression connectors.
- .6 Provide watertight fittings for conduits entering the top or sides of surface mounted terminal cabinets, annunciator transponders and control panels.

2.6 Special Environment

- .1 Devices shall be moisture-proof where located in moisture area. Devices shall be weather-proof where located outside.
- .2 Provide heater and power to heater including breaker and wiring, (break may not be shown on drawing), for devices located in cold area as required by manufacturer.

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- .3 Where the devices located in cold and/ or hot area, locate addressable module in warm area, and conventional devices in cold and/ or hot area.
- .4 Provide tamper proof wire guard where required.

PART 3 - EXECUTION

3.1 Installation

- .1 Equipment
 - .1 Install all equipment in accordance with CAN/ULC-S524 "Standard for the Installation of Fire Alarm Systems", the manufacturer's instructions, Ontario Building Code, Underwriter's Laboratory of Canada, Electrical Safety Code, these Documents and requirements of Local Authority Having Jurisdiction. This shall include appropriate settings for speaker transformer taps.
 - .2 In the event that the information given in the Specification and/or shown on the Drawings is in conflict with the Code and/or the requirement of authorities having jurisdiction, bring this to the attention of the Consultant, and do not proceed with the work until the matter is clarified.
- .2 Connections to Other Systems
 - .1 Sprinkler and Fire Standpipe System Connections
 - .1 Provide wiring and connections to all flow switches, supervised valves and pressure switches supplied by Division 23 Mechanical.
 - .2 Provide wiring and connections to sprinkler and fire standpipe pumps equipped with supervisory contacts provided by Division 23 Mechanical for 'Loss of Power', 'Phase Reversal' and 'Pump(s) Running' indications.
 - .2 Motor Control Connections
 - .1 Provide all wiring and connections from the fire alarm system to motor starters as required for shut-down and/or start-up. Co-ordinate connection and location with Division 23 Mechanical for proper system operation.
 - .2 Wiring for local fans operation on smoke condition shall be installed by Division 26 from duct mounted smoke detectors to the terminal panel adjacent to the motor control panel or the starter.
 - .3 Elevator System Connections
 - .1 Provide all wiring and connections from the fire alarm control panel, and required detectors to the elevator controllers. Provide one signal for initiating elevators to Ground Floor and another signal for initiating elevators to alternate floor if Ground Floor elevator lobby smoke detector is activated.

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.4 Door Device Connections

- .1 Provide power, wiring, conduit and connections to electrical door hardware, door hold-open devices and door control devices for proper release operation. Co-ordinate installation with the hardware installer.

3.2 Testing and Certification

- .1 Arrange with the manufacturer to conduct a complete inspection and test of all installed fire alarm and voice communication equipment including all components such as manual stations, signaling devices, heat detectors, smoke detectors, speakers, fire fighters handsets, controls, etc. Test and verify connections to equipment of other Division such as sprinkler valves, elevators, etc. Co-ordinate with and arrange for staff of other divisions to be present where required.
- .2 Provide staff to test devices and all operational features of the system for witness by the Consultant and Authority having jurisdiction. Provide 2-way radio communication at each annunciator, control point and other areas in the building as required. All testing must be witnessed by Owner's representative prior to acceptance.
- .3 Test and verify the total system to ensure satisfactory operation in conformance with latest version of CAN/ULC-S536 and CAN/ULC-S537, "Standard for the Verification of Fire Alarm System Installations".
- .4 Carry out testing, verification and certification as follow:
 - .1 System test in conjunction with the manufacturer.
 - .2 Correction of all deficiencies.
 - .3 Submission of test results to Consultant for review including letter of certification from the manufacturer(s).
 - .4 Witness of complete system by Consultant and/or his representatives.
 - .5 Correction of any deficiencies noted.
 - .6 Acceptance of the system by the Consultant.
 - .7 Witness of system test by authority having jurisdiction.
 - .8 Correction of any deficiencies requested by authority having jurisdiction.
 - .9 Submission of manuals with final verification sheets.
- .5 All costs involved in the testing and certification shall be included in the Tender Price.

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3.3 Training

- .1 Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.
 - .1 Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 4 hours training.
 - .2 Schedule training with the Owner at least seven days in advance.

END OF SECTION

Electrical Heating Equipment

PART 1 - GENERAL**1.1 General Requirements**

- .1 The General Conditions of CCDC 2 and the General Requirements of Division 1, form part of this section, and must be read in conjunction with the requirements of this section, and all related sections.
- .2 Provide the following electric heating assemblies and system complete with all components/accessories and controls:
 - .1 Electric baseboard heaters.
 - .2 Electric cabinet heaters.
- .3 Electric duct mounted heaters are excluded.

1.2 References

- .1 Comply with the requirements of the latest editions of the following:
 - .1 CSA C22.2 No. 130 – Requirements for Electrical Resistance Heating Cables and Heating Device Sets.
 - .2 CSA C22.2 No. 46 – Electric Air – Heaters.
 - .3 CSA C22.2 No. 72 – Heater Elements.
 - .4 CAN/CSA C273.4 – Performance Requirements for Electric Heating Line-Voltage Wall Thermostats.
 - .5 CAN/CSA C828 – Performance Requirements for Thermostats Used with Individual Room Electric Space Heating Devices.

1.3 Submittals

- .1 Submit Shop Drawings and manufacturer's data in accordance with Section 260100.
- .2 Product Data: dimensions, mounting methods, characteristics, performance criteria, materials, accessories, mechanical and electrical data, Product characteristics and limitations.
- .3 Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.

1.4 Qualifications

- .1 Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

Electrical Heating Equipment

PART 2 - PRODUCTS**2.1 Electric Baseboard Heaters**

- .1 Manufacturers:
 - .1 Chromalox
 - .2 Stelpro
 - .3 Ouellet
 - .4 Approved Alternate
- .2 Assembly: ULC listed and labeled with terminal boxes on both ends, covers, controls and all mounting accessories.
- .3 Heating Elements: Through-type nickel chromium element enclosed in mineral insulation in stainless steel sheath fitted with aluminum fins.
- .4 Cabinet: Pre-drilled back for securing to wall. Integral air diffusion reflector with wireway at bottom. Front inlet/front outlet. Minimum 20 gauge steel or extruded aluminum equivalent in strength with front panel, end panel, end caps, corners, and joiner pieces to snap together. Furnish full-length damper.
- .5 Finish: Clear anodized aluminum or powder coated finish, almond colour, unless otherwise required.
- .6 Control: Heater shall be controlled by remote thermostat. Provide wall-mounted thermostat, control relay, control transformer and control wiring.
- .7 Surface wall-mounted at low level. Co-ordinate with Architect for more installation requirements.
- .8 Heaters in washrooms shall be complete with Aluminum cabinet and clear anodized aluminum finish.

2.2 Electric Cabinet Heaters

- .1 Manufacturers:
 - .1 Chromalox
 - .2 Stelpro
 - .3 Ouellet
 - .4 Approved Alternate
- .2 Assembly: ULC listed and labeled assembly with terminal box, covers, controls and all mounting accessories.
- .3 Heating Elements: Through-type nickel chromium element enclosed in mineral insulation in stainless steel sheath fitted with aluminum fins.

Electrical Heating Equipment

- .4 Cabinet: Pre-drilled back for securing to wall. Adapter for ceiling mounted unit. Integral air diffusion reflector with wireway at bottom. Front inlet/front outlet. Minimum 20 gauge steel or extruded aluminum equivalent in strength with front panel, end panel, end caps, corners, and joiner pieces to snap together. Furnish full-length damper.
- .5 Finish: Clear anodized aluminum or powder coated finish, almond colour, unless otherwise required.
- .6 Fan: Direct-drive, statically and dynamically balanced, with fan guard.
- .7 Motor: Permanently lubricated, totally enclosed, ball bearing type, built-in thermal overload protection, built-in safety disconnect switch or plug-in electrical connection. Where power supply voltage is not matched with motor, provide built-in transformer for motor.
- .8 Control: Heater shall be controlled by remote thermostat. Provide wall-mounted thermostat, control relay, control transformer and control wiring.
- .9 Applications: Wall and/or ceiling mounted as shown on Drawings; recessed, semi-recessed and surface mounted. Verify the exact application and co-ordinate more installation requirements with Architect before ordering.

2.3 Thermostats

- .1 Adjustable type.
- .2 Temperature range: 10 - 30°C.
- .3 Operating differential of +1°C.

PART 3 - EXECUTION

3.1 Installation

- .4 For recessed units, verify recess dimensions are correct size.
- .5 Verify wall construction is ready for installation.
- .6 Verify concealed blocking and supports are in place and connections are correctly located.
- .7 Install the electric heaters in accordance with the manufacturer's instructions.
- .8 Use wire in electric heaters, which is specifically approved for electric heater use.
- .9 Install equipment exposed to finished areas after walls and ceilings are finished and painted. Avoid damage.
- .10 Protection: Provide finished cabinet units with protective covers during remainder of construction.
- .11 Unit Heaters: Provide at locations as indicated on Drawings. Coordinate to assure correct recess size for recessed units.

Electrical Heating Equipment

- .12 Install electric heating equipment including devices furnished by manufacturer but not factory-mounted. Furnish copy of manufacturer's wiring diagram submittal. Install electrical wiring in accordance with manufacturer's submittals.
- .13 The installation shall be inspected by the manufacturer's approval for the completed installation.
- .14 Perform the heater tests to ensure that all heaters, fans and heating controls are operating properly. Submit the test reports.

END OF SECTION

Electrical Commissioning

PART 1 - GENERAL

1.1 General Requirements

- .1 Conform to the General Conditions in Division 1.
- .2 Conform to the electrical General Requirements 26 01 00.
- .3 Provide labour, material and expertise to conduct the commissioning process as outlined in this Specification section.

PART 2 - PRODUCTS

2.1 Equipment

- .1 The Contractor and Manufacturers shall provide all instrumentation and equipment necessary to conduct the tests specified. The Contractor shall advise the Consultants of instrumentation to be used and the dates the instruments were calibrated.

PART 3 - EXECUTION

3.1 The Commissioning Process

- .1 The commissioning process consists of:
 - Shop Drawings and Record Drawings
 - Installation inspection and equipment verification
 - Independent testing Sub-Contractor
 - Testing of equipment and systems
 - Commissioning meetings
 - Operating and maintenance manuals
 - Operating training
 - Commissioning Agent testing
 - Systems Demonstration and turnover
 - Testing forms
 - Warranties

3.2 Shop Drawings and Record Drawings

- .1 Conform to Section 26 01 00 for requirements for Shop Drawings and record drawings.

Electrical Commissioning

3.3 Installation Inspection and Equipment Verification

- .1 The Contractor shall co-ordinate with the Consultant who will inspect the electrical installation.
- .2 The Contractor shall complete the equipment verification forms for each piece of equipment. The forms shall be included in the operating and maintenance manual. The equipment data shall include:
 - Manufacturers name, address and telephone number
 - Distributors name, address and telephone number
 - Make, model number and serial number
 - Voltage and current ratings

3.4 Testing of Equipment and Systems

- .1 The electrical contractor shall be responsible for all tests detailed in the Electrical Specification and those tests required by a manufacturer as part of their installation requirements.
- .2 The electrical contractor shall schedule all tests that are to be witnessed by the Electrical Consultant or the Commissioning Agent. The Electrical Contractor shall complete and sign the testing forms.
- .3 The electrical contractor shall conduct tests on the following equipment as a minimum. Refer to the individual specification sections for test procedures.
 - Co-ordination Study
 - Switchboard
 - Lighting Control System
 - Power and lighting panels
 - Cables
 - Emergency lighting
 - Communication system
 - Security systems
- .4 When all testing has been completed and all mechanical and electrical systems are operational, the electrical contractor shall conduct system load balance measurements, infra-red test and harmonics tests.

Electrical Commissioning

3.5 Commissioning Meetings and Reporting

- .1 The electrical contractor shall include the schedule for all tests in the construction schedule.
- .2 The commissioning meetings shall occur during the regular construction meetings. The testing schedules and results of all tests shall be reviewed.
- .3 All testing forms and reports associated with the electrical systems shall be directed to the Consultant with copies to the Architect, Commissioning Agent and the Owner.
- .4 The forms and reports to be issued shall include
 - Shop Drawings, issued and accepted
 - Equipment verification forms
 - Testing forms
 - Reports resulting from tests
 - Testing schedule
 - Minutes of commissioning meetings
 - Manufacturers Certificates

3.6 Operating and Maintenance Manual

- .1 Conform to Section 26 01 00 for requirements of the O&M Manuals.

3.7 Operator Training

- .1 Conform to Section 26 01 00 for requirements for Instructions to Operating Staff for each system and equipment.
- .2 The training shall be provided by qualified technicians or electricians and shall be conducted in a classroom and at the equipment or system. The training sessions shall be scheduled, co-ordinated and videotaped by the Commissioning Agent.
- .3 Each training session shall be structured to cover:
 - The operating and maintenance manual
 - Operating procedures
 - Maintenance procedures
 - Trouble-shooting procedures
 - Spare parts

Electrical Commissioning

- .4 Submit a course outline to the Consultant before training commences. Provide course documentation for up to eight people
- .5 The training sessions shall be scheduled and co-ordinated by the Commissioning Agent. The Commissioning Agent shall video tape the sessions.

- .6 Training shall be provided for the following systems:

<u>System</u>	<u>Minimum Training Times</u>
Electrical System	8 hours

- .7 The electrical contractor shall conduct a walk through of the installation with the Owner's Representative, Building Operator and/or Custodian, as well as the Commissioning Agent. During the walk through, the electrical contractor shall:
 - .1 Identify equipment
 - .2 Identify electrical panels
 - .3 Identify starters and disconnects
 - .4 Review the electrical power distribution
 - .5 Review the light power distribution
 - .6 Review the switch gear
 - .7 Identify the general maintenance procedures
 - .8 Operating and programming of lighting controls.

3.8 Commissioning Agent

- .1 A Commissioning Agent (CA) shall be hired by the Owner.
- .2 The CA responsibilities shall include:
 - .1 Preparing the commissioning plan
 - .2 Co-ordinating with the electrical contractor to schedule tests
 - .3 Preparing a test form manual
 - .4 Witnessing selected tests
 - .5 Receiving all test forms
 - .6 Co-ordinating the electrical contractor's training
 - .7 Chair the commissioning meetings

Electrical Commissioning

- .3 The electrical contractor shall conform to the requirements of, and co-operate with the CA.
- .4 The electrical contractor shall provide assistance to the CA and have appropriate and experienced personnel available during the performance testing procedure. Each electrical system shall be tested in the operational mode.

3.9 Electrical System Demonstration and Turnover

- .1 The system demonstration and turnover to the Owner shall occur when:
 - The installation is complete
 - The acceptance test conducted by the Consultant has been completed successfully
 - Training has been completed
 - Equipment Operating and Maintenance Manuals have been presented accepted by the electrical consultant and the Owner's Representative
 - System operating manuals have been presented and accepted by the electrical consultant and the Owner's Representative
 - Shop-drawings have been updated
 - As-built drawings have been completed
- .2 The Commissioning Process has been completed successfully and system operation accepted by the electrical consultant and Commissioning Agent.
- .3 The systems demonstration shall be conducted by the electrical contractor and equipment manufacturers. The demonstration shall cover a physical illustration of equipment installation and operation.

3.10 Testing Forms

- .1 The electrical contractor and Equipment Manufacturers shall fill out the forms issued by the C A at such time as he is ready to begin the Commissioning Process. The forms must be approved by the Consultant and the Owner's Representative before they are used.

3.11 Warranties

- .1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by the Owner.
- .2 The Contractor shall fill out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
- .3 Refer to Division 1 General Conditions for the requirements during the warranty period.

Electrical Commissioning

3.12 Commissioning Process Allocation

- .1 The Commissioning Process shall be allocated a value equal to 5% of the Contract. The electrical contractor may draw from this allocation as each of the Commissioning Process is completed.
- .2 The 5% Allocation will be accorded the appropriate component value in accordance with the following Breakout List:

Shop Drawings	$\frac{1}{2}$
Cable Testing	$\frac{1}{4}$
Electrical Distribution Completion	2
Lighting & Lighting Control	1
Co-ordination Study Acceptance	$\frac{1}{4}$
Communication/Security Test Completion	$\frac{1}{4}$
Training Completed	$\frac{1}{4}$
O& M Manual Acceptance	$\frac{1}{4}$
As Built Drawings Acceptance by Owner	$\frac{1}{4}$

Total Percentage of Contract Price 5%

- .3 The electrical contractor shall submit all test and verification forms. The Consultant will use these forms to calculate percentage complete.
- .4 The electrical contractor may claim up to 3% of the Contract from this allocation leading up to performance testing. The remaining 2% shall not be paid out until the performance testing, O & M manuals and training have been completed satisfactorily.
- .5 The electrical contractor's failure to meet the schedule issued by the C. A. will result in the Owner hiring other parties to complete the items identified in the above Breakout List for the Commissioning Process Allocation and recover such costs from this 5% Allocation

END OF SECTION

Communication Systems

PART 1 - GENERAL

1.1 GENERAL

- .1 General: Provide a complete communication systems: General Systimax Standards, Grounding and Bonding for Communication Systems, Interior Pathways for Communications Systems, Firestopping, Exterior Pathways for Communications Systems, Identification for Communication Systems, Communication Equipment Rooms, Communications Copper Backbone – Category 3, Communications Fibre Backbone Multimode 550, Communication Horizontal Cabling – Category 6, Communication Consolidation Points, Communication Wireless AP Outlets, Communication MUTOA Outlets, Testing of Communications Systems, etc. Refer to the attachment appendix A (City of Brampton’s IT Performance Specification, Division 27, Communications New Build Guidelines - total of 60 pages) and comply accordingly.

END OF SECTION



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The Corporation of the City of Brampton

IT Performance Specification

Division 27, Communications

New Build

Version 1.6

March 18, 2021

Revised by:

Marc Flores

Network Administrator – Cable Plant

**This document is a living document and will be updated as needed.
It is the Consultant / Contractors responsibility to inquire with CoB IT Department that
the latest version of this document is being used.**

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REVISION HISTORY

Version #	Date	Revised by	Description of Revisions
1.1	18-Jan-06	MCW Consultants	Initial Creation
1.2	26-Feb-10	David Barnwell	Addition of test-results/as-built documentation requirements, cabinet layout, triple became double drop standard. UPS requirements added
1.3	23-Feb-15	David Barnwell	Removed Cat5e and lower performance fibre
1.4	15-Jun-17	Marc Flores	Updated Labeling, added Appendixes, removed part numbers from spec materials and referred to appendixes (Refer to Appendix for part number changes). Document combined into 1 Living document. Added Fire stopping section.
1.5	31-Jan-19	Marc Flores	Updated patch cable colouring standards Removed Gigaspeed patch panel and replaced with only M2000 patch panels Revised appendix drawings
1.6	18-March-21	Marc Flores	Added CAT6a cabling for Wifi Access Points Revised part numbers in Wireless section 271544 appendix.

GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

1 SCOPE OF WORK

1.1 Include detailed design, manufacturer, supply, installation, inspection and testing of grounding and bonding systems and items contained within as described in these performance specifications and summarized in the following elements of the work:

.1 The scope of work included within the section includes grounding and bonding requirements of communication systems.

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of grounding and bonding systems and related items shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
- TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
- TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Infrastructure Standard
- TIA/EIA-942 Telecommunications Infrastructure Standard for Data Centres
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual
- BICSI – Customer-Owner Outside Plant Design Manual
- CISCA – Ceiling and Interior Systems Construction Association

2.2 All bonding and grounding elements shall be constructed from copper.

2.3 Provide a solid copper tin plated busbar with holes for use with standard-sized two hole lugs, have minimum dimensions of 6.3 mm x 100 mm x 610 mm (0.25 in x 4 in x 12 in) within the main communication room mounted to the backboard.

- 2.4 Provide a solid copper tin plated busbar with holes for use with standard-sized two hole lugs, have minimum dimensions of 6.3 mm x 100 mm x 305 mm (0.25 in x 4 in x 6 in) within each communication room mounted to the backboard.
- 2.5 Provide a continuous unbroken Telecommunication Bonding Backbone (TBB) wire between the main communication room grounding busbar and the grounding busbar of the communication room on the top floor of a multi-story building. TBB shall be sized based on the following:

TBB Length Linear m (ft)	TBB Size AWG
Less than 4 (13)	6
4 to 6 (13 to 20)	4
6 to 8 (20 to 26)	3
8 to 10 (26 to 33)	2
10 to 13 (33 to 44)	1
13 to 16 (44 to 52)	1/0
16 to 20 (52 to 66)	2/0
Greater than 20 (66)	3/0

- 2.6 Each communication room in a multi-story building shall be bonded to the TBB with a wire sized to match that of the TBB. The bonding wire shall be coupled to the TBB with an exothermic weld.
- 2.7 All cabinets, cable trays, conduits and intrabuilding armoured cable shall be bonded to the busbar in the room to which they are located with a minimum #6 AWG wire.
- 2.8 All metal parts of the access floor shall be bonded to ground in accordance with CEC Rule 10-406. A minimum of every fourth pedestal shall be bonded to ground with a minimum #6 AWG wire.
- 2.9 Bond wire basket cable trays to ground in the following way:
 - .1 Ground at the end of a continuous run
 - .2 Ground continuous runs every 18.3 m (60 ft).
 - .3 All on-site fabricated sections (any sections that have been cut in any way) shall be bonded to ground at both ends. This includes but is not limited to Bends, Crosses, Tees, "Y" fittings and vertical fittings.
 - .4 Each section of tray that is spliced to another section of tray shall be spliced with a minimum of four (4) splices. Either Flexmate or Splice Washers shall be used for splicing.

3 **MATERIALS**
NIL

4 **FIELD QUALITY CONTROL**
NIL

INTERIOR PATHWAYS FOR COMMUNICATION SYSTEMS

1 SCOPE OF WORK

1.2 Include detailed design, manufacturer, supply, installation and inspection of communication pathway systems as described in these performance specifications and summarized in the following elements of the work:

.2 The scope of work included within the section includes conduits, cable trays and slings supports.

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of pathway systems shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
- TIA/EIA-606-A Administration Standard for Commercial Telecommunications Infrastructure
- BICSI – Telecommunication Distribution Methods Manual

2.2 Outlet boxes shall be 100 mm (4 in) x 100 mm (4 in) x 57 mm (2.25 in) with a single gang adapter plate. Outlet boxes designated for an open office area shall be mounted at 775 mm (30.5 in) AFF. Outlet boxes designated as voice for a wall mounted public phone shall be mounted at 1120 mm (44 in) AFF. Mounting heights measured from the bottom of the outlet box.

2.3 A minimum of one 27 mm (1 in) conduit shall run from the outlet box to the ceiling space. A conduit run shall serve no more than one outlet box.

2.4 Sling supports shall support the cable every 1.2 m (4 ft) from the conduit to the nearest cable tray.

2.5 Cable tray sized not to exceed 40% fill shall be the main pathway system. Run cable tray in a continuous run through every main corridor and walk way and up to the exterior wall of the communication rooms.

2.6 Cable shall pass through into the communication rooms from the cable tray with the use of an appropriately rated re-enterable firestop sized to not exceed 40% fill.

2.7 Cable tray sized not to exceed 40% fill shall be the main pathway system within the communications rooms and data centres. Run cable tray in such a way as to continuously support horizontal cable and backbone cable between cable entrance points, backboards and cabinets.

- 2.8 Cable tray shall be modified on-site by the contractor as per manufacturer’s specifications to suit the design and on-site conditions.
- 2.9 All cable tray inner corners shall consist of a 45-degree angle not a 90 degree angle. In corridors, a sweep bend shall be used consisting of a 300 mm (11.8 in) radius for 150 mm (6 in) wide cable tray, 400 mm (15.85 in) radius for 300 mm (12 in) wide cable tray and 500 mm (19.7 in) radius for 450 mm (18 in) wide cable tray.
- 2.10 Cable trays shall be installed a minimum of 75 mm (3 in) above T-bar ceilings and have a minimum of 150 mm (6 in) of clear space above the cable tray.
- 2.11 Cable trays shall be supported at both ends of each section of 3m (10 ft.), 600 mm (12 in) from the ends.
- 2.12 All pathways shall avoid potential sources of electromagnetic interference by maintaining clearances of at least:
 - a. 305 mm (1 ft.) from fluorescent ballasts.
 - b. 305 mm (1 ft.) from electrical power distribution conduit and cable, less than 1kV.
 - c. 1000 mm (3.3 ft.) from electrical power distribution conduit and cable, more than 1kV.
 - d. 1220 mm (4 ft.) from motors and transformers.
 - e. 305 mm (1 ft.) from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and power distribution and conduits.
 - f. 305 mm (1 ft.) from HVAC equipment, ducts and pipes
- 2.13 Conduit capacity shall never exceed 40% fill as per TIA/EIA-569-B standards. Conduit capacity shall be as follows:

Conduit Size mm (in)	Cable Diameter mm (in)	
	<=6.1 (0.24)	7.4 (0.29)
21 (0.75)	3	2
27 (1)	6	3
35 (1.25)	10	6
41 (1.5)	15	7
53 (2)	20	14
63 (2.5)	30	17
78 (3)	40	20

- 2.14 If the capacity of the conduit is exceeded, then the next trade size shall be used.
- 2.15 If conduit has an internal diameter of 53 mm (2 in) or less, then the bend radius shall be at least six times the internal diameter. If conduit has an internal diameter of more than 53 mm (2 in) then the bend radius shall be at least ten times the internal diameter.
- 2.16 The maximum number of bends between cable pull boxes in a conduit run shall be two 90° bends.
- 2.17 Conduit runs shall have no continuous sections longer than 30 m (100 ft.).

2.18 If a conduit run requires a reverse bend between 100° and 180° then a pull box shall be inserted at the bend.

2.19 Pull boxes shall be adequately sized for the radius of the connecting conduits and the manufacturer's specified cable bend radius, as follows:

Conduit Size mm (in)	Pull Box Width mm (in)	Pull Box Length mm (in)	Pull Box Depth mm (in)	Width Increase for Additional Conduit mm (in)
27 (1)	102 (4)	406 (16)	76 (3)	51 (2)
35 (1.25)	152 (6)	50 (20)	76 (30)	76 (3)
41 (1.5)	203 (8)	686 (27)	102 (4)	102 (4)
53 (2)	203 (8)	914 (36)	102 (4)	127 (5)
78 (3)	305 (12)	1219 (48)	127 (5)	152 (6)

2.20 Pull boxes shall be installed in fully accessible ceiling spaces.

2.21 Support and secure all boxes independent of the conduit connected thereto.

2.22 All conduit ends shall be protected by insulating bushings.

2.23 Use only manufacturer approved cable lubricants. Any excess lubricant shall be cleaned to leave conduit exteriors suitable for painting.

2.24 All conduits shall be left with a nylon pull string installed.

3 MATERIALS

3.1 Obtain cable tray components through one source from a single manufacturer.

3.2 Cable tray shall have the following characteristics:

- .1 Continuous, rigid, welded steel wire mesh.
- .2 Continuous T-weld on top rail of tray.
- .3 All cable tray shall be purchased in 3 m (10 ft.) straight sections.
- .4 Finish: electroplated zinc coating

3.3 Obtain sling support components through one source from a single manufacturer.

3.4 Sling supports shall have the following characteristics:

- .1 Comply with UL and EIA/TIA requirements for structured cabling systems.
- .2 Comply with NFPA 90A for plenum spaces.
- .3 Rated load weight shall be 100 lbs.

4 FIELD QUALITY CONTROL

4.1 NIL

EXTERIOR PATHWAYS FOR COMMUNICATION SYSTEMS

1 SCOPE OF WORK

1.3 Include detailed design, manufacturer, supply, installation and inspection of communication pathway systems as described in these performance specifications and summarized in the following elements of the work:

.3 The scope of work included within the section includes underground ducts and maintenance holes.

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of pathway systems shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Infrastructure Standard
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
- TIA/EIA
 - Provide a minimum of three 103mm (4") conduits from the property line (location to be recommended by the utility) to the entrance facility designated for Access Provider use. Do not include more than two 90-degree bends in the conduit run between pull points. Never exceed a 90-degree bend. Conduits entering the room shall extend above the floor by 103 mm (4 in) AFF or extend down below the ceiling to 2.4 m (8 ft.) AFF. All conduits entering the building shall be sealed with a rubber plug or water plug.
- -606-A Administration Standard for Commercial Telecommunications Infrastructure
- BICSI – Telecommunication Distribution Methods Manual
- BICSI - Customer Owner Outside Plant Design Manual

2.2 A minimum of four (4) 103 mm (4 in) underground ducts shall connect two campus buildings. All campus buildings shall be connected to the building containing the main campus equipment room or data centre in a star configuration.

2.3 Only data, voice, CATV, security and fire alarm communication cables shall occupy these underground ducts. All other services such as power shall be run in a separate duct system.

2.4 Data, voice, CATV and security/fire alarm shall each be run in a separate conduit within the same duct system.

-
- 2.5 A maintenance hole shall be located within a duct run whenever one of the following apply:
- When calculation results for conduit pulling, tension exceeds the cable manufacturers recommended limits (typical cable cannot exceed a total installation load of 2700 Newton, 600 lbs.).
 - When a cables maximum available reel length is exceeded and a splice to a second length of cable is required.
 - Whenever a splice is required to split a large cable into two or more cables (for example a 24-strand fibre cable spliced to two 12-strand fibre cables).
- 2.7 The following equation shall be used to calculated pulling tensions for straight inclined or horizontal conduit: $T = T_0 + w (fx +/- h)$
- T = the pulling tension.
 - T_0 = the tail load at the reel, typically a load of 890 Newton (200 lbf).
 - f = coefficient of friction between the cable and conduit, typically 0.36 for PVC conduit and low density polyethylene.
 - w = weight per unit length of cable (N/m or lb/ft). For metric units, the cable weight (Kg) must be converted to the force of its weight by multiplying it by 9.8 N/Kg.
 - x = horizontal projection of segment.
 - h = vertical projection of segment (h is positive for an increase in elevation, negative for a decrease in elevation and 0 for no change in elevation).
- 2.8 The following equation shall be used to calculated pulling tensions for uniformly curved segment of conduit: $T = (wr) PTR$
- T = the pulling tension.
 - T_0 = the tail load from the previous section.
 - f = coefficient of friction between the cable and conduit, typically 0.36 for PVC conduit and low density polyethylene.
 - w = weight per unit length of cable (N/m or lb/ft.). For metric units, the cable weight (Kg) must be converted to the force of its weight by multiplying it by 9.8 N/Kg.
 - r = radius of curvature of the bend (m or ft.).
 - a = displacement angle of bend (degrees).
 - PTR = pulling tension ratio as calculated from the chart below:

T ₀ (wr)	f a													
	5	10	15	20	25	30	35	40	45	50	55	60	65	70
0.2	0.29	0.38	0.48	0.58	0.68	0.79	0.90	1.02	1.15	1.29	1.44	1.59	1.76	1.95
0.4	0.50	0.60	0.70	0.81	0.92	1.05	1.18	1.32	1.47	1.63	1.80	1.99	2.19	2.41
0.7	0.81	0.92	1.05	1.18	1.32	1.47	1.63	1.80	1.99	2.19	2.41	2.65	2.90	3.18
1.1	1.23	1.38	1.53	1.70	1.88	2.07	2.28	2.50	2.75	3.01	3.30	3.62	3.96	4.33
1.8	1.99	2.19	2.41	2.64	2.90	3.18	3.48	3.81	4.17	4.56	4.99	5.45	5.96	6.51
2.8	3.07	3.36	3.68	4.03	4.41	4.82	5.27	5.76	6.29	6.87	7.50	8.19	8.95	9.77
4.5	4.92	5.38	5.88	6.42	7.01	7.66	8.36	9.13	10.0	10.9	11.9	13.0	14.1	15.4
6.5	7.10	7.75	8.47	9.24	10.1	11.0	12.0	13.1	14.3	15.6	17.1	18.6	20.3	22.2
9.3	10.2	11.1	12.1	13.2	14.4	15.7	17.2	18.7	20.4	22.3	24.3	26.6	29.0	31.6
12.0	13.1	14.3	15.6	17.0	18.6	20.3	22.1	24.2	26.4	28.8	31.4	34.2	37.4	40.8
16.0	17.5	19.1	20.8	22.7	24.8	27.0	29.5	32.2	35.1	38.3	41.8	45.6	49.8	54.3
20.0	21.8	23.8	26.0	28.4	31.0	33.8	36.9	40.2	43.9	47.9	52.3	57.0	62.2	67.9
24.5	26.7	29.2	31.8	34.7	37.9	41.4	45.1	49.3	53.7	58.7	64.0	69.8	76.2	83.2
30.0	32.7	35.7	39.0	42.5	46.4	50.6	55.3	60.3	65.8	71.8	78.4	85.5	93.3	102
37.0	40.4	44.1	48.1	52.5	57.2	62.5	68.2	74.4	81.2	88.6	96.6	105	115	126
45.0	49.1	53.6	58.5	63.8	69.6	76.0	82.9	90.5	98.7	108	118	128	140	153
54.0	58.9	64.3	70.2	76.6	83.5	91.2	99.5	109	118	129	141	154	168	183
65.0	70.9	77.4	84.5	92.2	101	110	120	131	143	156	170	185	202	221
77.0	84.0	91.7	100	109	119	130	142	155	169	184	201	219	239	261
89.0	97.1	106	116	126	138	150	164	179	195	213	232	254	277	302
100	109	119	130	142	155	169	184	201	219	239	261	285	311	339

2.9 Pulling tensions shall be calculated from both ends as if the cable were pulled from either end and the worst case shall be used as the reference. However installers should pull from the end with the lower tension.

2.10 Maintenance holes shall have the following characteristics:

- Precast
- Minimum interior dimensions of 3.6m (12ft) long x 1.8m (6ft) wide x 2.1m (7ft) high
- Equipped with a built-in sump
- Minimum entrance opening of 762 mm (30") interior diameter
- Equipped with a corrosion-resistant pulling iron at either end
- Grounding system
- Cable racks on both side
- Fixed or movable ladder
- Capable of supporting the heaviest anticipated weight, based on the following table:

Rating	Heaviest anticipated weight
Light duty	Pedestrian traffic only
H-5 (5,000 Kg)	Sidewalk applications and occasional non-deliberate traffic
H-10 (10,000 Kg)	Driveways, parking lots, and off-road applications subject to non-deliberate heavy traffic
H-20 (20,000 Kg)	Deliberate heavy traffic

- 2.11 Maintenance holes shall be located based on the following:
- Out of the roadway (when possible)
 - Away from locations where water is likely to pool
 - Allow for adequate traffic control when the MH is open
 - Not jeopardize vehicular or pedestrian traffic flow.
 - Not in or near an intersection or near a point where a curve occurs in a road.
- 2.12 Duct systems shall have the following clearances:
- Below the frost line
 - 150 mm (6 in) when crossing pipes
 - 300 mm (12 in) when parallel to pipes
 - 75 mm (3 in) from power run in concrete
 - 300 mm (12 in) from power direct buried
- 2.13 All duct runs and maintenance holes shall be clearly shown on as built drawings indicating number and size of ducts and the cable size in fibre strands and copper pairs contained within.
- 3 **MATERIALS**
- 3.1 NIL
- 4 **FIELD QUALITY CONTROL**
- 4.1 NIL

IDENTIFICATION FOR COMMUNICATION SYSTEMS

1 SCOPE OF WORK

- 1.2 Include detailed identification and administration of communication system as described in these performance specifications and summarized in the following elements of the work:
- .3 The scope of work included within the section includes identification and administration of an end-to-end structured cabling system and its pathways and spaces.

2 DESIGN AND PERFORMANCE REQUIREMENTS

- 2.1 Inspection, testing and administration of identification and administration shall comply with the following standards, unless otherwise stated:
- Canadian Electric Code
 - Ontario Building Code
 - TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
 - TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
 - TIA/EIA-568-B.3 Commercial Building Telecommunication Cabling Standard – Part 3: Optical Fibre Cabling Components Standard
 - TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
 - TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
 - TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Infrastructure Standard
 - TIA/EIA-942 Telecommunications Infrastructure Standard for Data Centres
 - CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
 - BICSI – Telecommunication Distribution Methods Manual
 - BICSI - Customer Owner Outside Plant Design Manual
- 2.2 Labelling shall be in accordance with the following:
- .1 All labelling shall be mechanically printed and follow the TIA/EIA-606-A guidelines and be in accordance with the requirements of this specification. Hand written labels are not permitted.
- .2 Cable labels shall be Vinyl construction with a white printing area and a clear tail that self-laminate the printed area when wrapped around the cable. The clear area should be of sufficient length to wrap around the cable at least 1.5 times.

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- .3 Vinyl identification labels shall appear on the following locations with the designations indicated on the cable schedule and drawings:
- Port identification on both ends of every cable
 - Port identification on the front of all faceplates
 - Port identification on the front of all patch panels
 - Panel identification on the front top right hand corner of all patch panels
 - Pair identification on the front of termination fields
 - Wireless identification on the front of all wireless access points
- .4 Lamicaid identification labels shall appear on the following locations with the designations indicated on the cable schedule and drawings:
- Cabinet identification on the top right hand side of the cabinet
- .5 All firestops shall be labelled stating “WARNING FIRESTOP SEAL DO NOT DISTURB” and also the contractors name, address and phone number, date installed, fire rating.
- .6 Horizontal cabling systems (faceplate ports, cable, patch panel ports) shall use the following labelling scheme: (DO NOT USE **X** IN THE LABELING USE LAN ROOM LETTER)
- 1st Data = **X**-001A where ‘**X**’ = ‘LAN ROOM LETTER’, ‘001’ = ‘port number’ and ‘A’ = 1st data port
 - 2nd Data = **X**-001B where ‘**X**’ = ‘LAN ROOM LETTER’, ‘001’ = ‘port number’ and ‘B’ = 2nd data port
- .7 Backbone cabling shall use the following labelling scheme (DO NOT USE **X** IN THE LABELING USE LAN ROOM LETTER):
- **TCX-2**-001-200 where ‘**TCX**’ = ‘Telecommunication **X**’, ‘2’ = ‘2 floor communication room and ‘001-200’ = ‘port 1-200’
- 8 Cabinets shall use the following labelling scheme:
- **TCX-1A** where ‘TCA’ = ‘Telecommunication LAN Letter’, ‘Cabinet Number
- .9 Wireless access points shall use the following labelling scheme: (See Appendix for Cable and Jack Colours)
- **X-W-01** where WL = ‘WIRELESS’, 01 = ‘wireless port number’ increasing by 1 for each extra wireless access point. W-02, W-03 etc. **(Where X is the LAN room Letter this drop terminates to)**
- .10 Elevator drops shall use the following labelling scheme: (See Appendix for Cable and Jack Colours) X = Lan room Letter
- **X-EL-01** where EL = ‘Elevator’, 01 = ‘port number’ . **(Where X is the LAN room Letter this drop terminates to)**

.11 Fire control panels shall use the following labelling scheme: (See Appendix for Cable and Jack Colours) X = Lan room Letter

- **X-FR-01** where FR = 'Fire', 01 = 'port number' **(Where X is the LAN room Letter this drop terminates to)**

.12 Bonding and grounding systems shall use the following labelling scheme:

- TMGB where 'TMGB' = 'Telecommunication Main Grounding Busbar'
- TGB-4B where 'TGB' = 'Telecommunication Grounding Busbar' and '4B' = '4th floor communication room B' and
- ESBC where 'ESBC' = 'Electrical Service Bonding Conductor'
- TBB-4B where 'TBB' = 'Telecommunication Bonding Backbone' and '4B' = '4th floor communication room B' and
- EBC-TCA where 'EBC' = 'Equipment Bonding Conductor', 'TCA' = 'Telecommunication Cabinet A'
- CBC-TCA-4B-001-200 where 'CBC' = 'Cable Bonding Conductor', 'TCA' = 'Telecommunication Cabinet A', '4B' = '4th floor communication room B' and '001-200' = 'port 1-200'

2.3 As-built drawings shall include, but are not limited to, the following:

- Work area port designations
- Main routing of pathways
- Cabinet elevations
- Backboard elevations
- Communication room layouts
- Riser routing and cable counts

2.4 A full-size copy of the as-built drawings shall be placed in every communication room.

3 **MATERIALS**
NIL

4 **FIELD QUALITY CONTROL**
NIL

FIRESTOPPING

NOTE TO SPECIFIER: in the design using EZ-Path - do not take tray through wall: Coordinate drawings to show tray terminating at wall or floor and resuming on other side.

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes Labor, materials and equipment necessary to complete the installation required for the items specified under this Section, including but not limited to:
1. Firestopping of Through Penetrations in Fire Rated Assemblies.

1.2 RELATED SECTIONS

- A. Related Work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.
- B. This Specification should be considered as an augmentation to Section 07 84 00 Firestopping and any or all sub sections of Section 07 84 00.
- C. This Section addresses those unique elements that affect the Firestopping of Information Technology cabling systems which may not be addressed in 07 85 00 or any of its sub-sections.

1.3 REFERENCES

- A. CAN4-S115-M, "Standard Method of Fire Tests of Firestop Systems".
- B. CAN/ULC-S115, "Standard Method of Fire Tests of Firestop Systems".
- C. Underwriters Laboratories Canada Inc. (ULC) – Fire Resistance Directory
- D. Underwriters Laboratories, Inc. (cUL) – Fire Resistance Directory of Products Certified for use in Canada.

1.4 PERFORMANCE REQUIREMENTS

- A. Fire rated cable pathway devices shall be used for ALL low-voltage, video, data and voice cabling, optical fibre raceways and certain high-voltage cabling where frequent cable moves, adds and changes may occur. Pathways required for high voltage cabling will be detailed on the prints. Such devices shall:
1. Meet the hourly fire-rating of fire rated wall and or floor penetrated.
 2. Be tested for the surrounding construction and cable types involved.
 3. Have ULC, cUL or cULus Systems permitting cable loads from; "Zero to 100% Visual Fill." This requirement eliminates need for fill-ratio calculations to be made

- by cable technicians to ensure cable load is within maximum allowed by ULC, cUL or cULus System.
4. Not have a constrictive inner liner that tightens around or compresses cables tightly together encouraging potential cross-talk or interference.
 5. Be “Zero-Maintenance”, zero-maintenance is defined as; No action required by cabling technician to open and/or close pathway for cable moves, adds or changes, such as, but not limited to:
 - a. Opening or closing of doors.
 - b. Spinning rings to open or close fabric liner.
 - c. Removal and or replacement of any material such as, but not limited to, firestop caulk, putty, pillows, bags, foam muffins, foam, foam plugs, foam blocks, or foam closures of any sort.
 - d. Furnish letter from manufacturer certifying compliance with this definition of “Zero-Maintenance”.
 6. Pathways shall be engineered such that two or more devices may be ganged together for larger cable capacities.
 7. Pathways shall be engineered to be re-enterable so they can be retrofitted and removed from around existing cables without cutting and re-splicing them.
 8. Cable Pathway Devices passing vertically through floors shall have equal FT Rating. (See UL System # F-A-3037, Item #4 “EZ-PATH Grid T-Rating Kit” Part # TRK444)
 9. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.
- B. Where non-mechanical pathways must be utilized, such as sealing (caulking) around single or grouped conduits, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction. Provide letter from manufacturer certifying compliance with this section.
- C. Cable pathway shall replace conduit sleeves in walls and floors, and;
 - a. When installed individually in floors, devices shall pass through core-drilled opening utilizing tested floor plates.
 - b. When multiple units are ganged in floors, devices shall be anchored by means of a tested grid.
 - c. When installed individually in walls, devices shall pass through core drilled opening utilizing tested wall plates.
 - d. When multiple units are ganged in walls, devices shall be anchored by means of a tested grid.
- D. Cable tray shall terminate at each fire barrier and resume on the other side such that cables pass independently through devices. Cable tray shall be properly supported on each side of fire barrier.

Note to Specifier: Coordinate drawings to show tray terminating at wall or floor and resuming on other side.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 30 00.
- B. Product Data: Provide manufacturer's standard catalog data for specified products demonstrating compliance with referenced standards and listing numbers of systems in which each product is to be used.
- C. Schedule of ULC, cUL or cULus System Drawings: Submit schedule of all expected opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings. If engineering recommendations are necessary, list these in the schedule too.
- D. ULC, cUL or cULus System Drawings: Furnish copies of all ULC, cUL or cULus Systems identified in schedule above. Include any engineering recommendations.
- E. Certificates: Product Certificate of Compliance from the firestop system manufacturer certifying material compliance with applicable code and specified performance characteristics.
- F. Installation Instructions: Submit manufacturer's printed installation instructions.

1.6 QUALITY ASSURANCE

- A. Products/Systems: Provide firestopping systems that comply with the following requirements:
 - 1. Firestopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is ULC, cUL or cULus, or another agency performing testing and follow-up inspection services for firestop system acceptable to authorities having jurisdiction.
 - 2. Firestopping products bear the classification marking of qualified testing and inspection agency.
- B. Installer Qualifications: Experience in performing work of this section who is qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products in accordance with specified requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery:
 - 1. Manufacturer's original, unopened, undamaged containers, identification labels intact identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable; qualified testing and inspection agency's classification marking; and mixing instruction for multi-component products.
 - 2. Handle and store products according to manufacturer's recommendations published in technical materials. Leave products wrapped or otherwise protected and under clean and dry storage conditions until required for installation.
- B. Storage and Protection:

1. Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.8 PROJECT CONDITIONS

- A. Do not install firestopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer.
- B. Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes.
- C. Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.
- D. Do not use materials that contain flammable solvents.
- E. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- F. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- G. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Specified Technologies Inc., or Approved Alternative.
- B. Single Source: Obtain firestop systems for each type of penetration and construction condition indicated only from a single manufacturer.

2.2 MATERIALS

- A. General: Use only firestopping products that have been tested for specific fire resistance rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.
- B. Firestop Sealants: STI SpecSeal® Brand or Approved Alternate single component latex formulations that upon cure do not re-emulsify during exposure to moisture, the following products are acceptable:
 1. Specified Technologies Inc. (STI) SpecSeal® Series SSS Sealant or Approved Alternate.
 2. Specified Technologies Inc. (STI) SpecSeal® Series LCI Sealant or Approved Alternate.

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- C. Firestop Putty: STI SpecSeal® Brand or Approved Alternate intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds, the following products are acceptable:
 - 1. Specified Technologies Inc. (STI) SpecSeal® Series SSP Putty or Approved Alternate

 - D. Firestop Pillows: STI SpecSeal® Brand or Approved Alternate re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag, the following products are acceptable:
 - 1. Specified Technologies Inc. (STI) SpecSeal® Series SSB Pillows or Approved Alternate.

 - E. Fire Rated Cable Pathways: STI EZ-PATH™ Brand or Approved Alternate device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
 - 1. Specified Technologies Inc. (STI) EZ-PATH™ or Approved Alternate Fire Rated Pathway
 - a. Series 22 or Approved Alternate
 - b. Series 33 or Approved Alternate
 - c. Series 44 or Approved Alternate

Note to Specifier: Coordinate drawings to show size device desired to accommodate future cable capacity. If no size is specified, contractors will use smallest size. Labor to install all three sizes is approximately the same.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of firestopping in accordance with manufacturer's installation instructions and technical information.
- B. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.
- C. Provide masking and temporary covering to protect adjacent surfaces.
- D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.
- B. Manufacturer’s Instructions: Comply with manufacturer’s instructions for installation of firestopping products.

3.3 FIELD QUALITY CONTROL

- A. Inspections: Owner shall engage qualified independent inspection agency to inspect through-penetration firestop systems.
- B. Keep areas of work accessible until inspection by authorities having jurisdiction.
- C. Where deficiencies are found, repair firestopping products so they comply with requirements.

3.4 ADJUSTING AND CLEANING

- A. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.
- B. Clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling as work progresses.

3.5 SCHEDULES:

Review this list and update as required, Contact STI for assistance

Penetrant Type	Concrete Floor	Concrete Wall	Gypsum Board Wall
Blank Opening	C-AJ-0100, C-AJ-0101	C-AJ-0100, C-AJ-101	
Metal Conduits	C-AJ-1080, C-AJ-1240, C-AJ-1353	C-AJ-1080, W-J-1098, W-J-1100	W-L-1049, W-L-1222, W-L-1168
Plastic Conduits/ Raceways	C-AJ-2140, C-AJ-2292	W-J-2018, W-J-2076	W-L-2093, W-L-2241
Cables	C-AJ-3214, C-AJ-3231, F-A-3015	C-AJ-3214, C-AJ-3231, W-J-3098, W-J-3099	W-L-3218, W-L-3219
Cable Trays	C-AJ-4029	W-J-4021, W-J-4022, W-J-4033	W-L-4008, W-L-4029, W-L-4043

3.6 DOCUMENTATION

- A. Place system stickers on each side of wall penetrations.
- B. Place a reproduction (photo copy) of the UL System description in a document protector and mount to the wall next to the wall penetration
 - 1. Highlight the section of the system description that lists the allowed cable types.

COMMUNICATION EQUIPMENT ROOMS

1 SCOPE OF WORK

- 1.1 Include detailed design, manufacturer, supply, installation, inspection and testing of communication rooms and items contained within as described in these performance specifications and summarized in the following elements of the work:
- .2 The scope of work included within the section includes architectural requirements, electrical systems, environmental requirements, cable management and pathways, and cabinets.

2 DESIGN AND PERFORMANCE REQUIREMENTS

- 2.1 Design, manufacturer, supply and installation of communication rooms and related items shall comply with the following standards, unless otherwise stated:
- Canadian Electric Code
 - Ontario Building Code
 - TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
 - TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
 - TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
 - TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
 - TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Infrastructure Standard
 - TIA/EIA-942 Telecommunications Infrastructure Standard for Data Centres
 - CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
 - BICSI – Telecommunication Distribution Methods Manual
 - BICSI – Information Transport Systems Installation Manual
 - BICSI – Customer-Owner Outside Plant Design Manual
 - Cisca – Ceiling and Interior Systems Construction Association

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- 2.2 Locate communication rooms in accordance with the following:
- .1 As close to the centre of, and on the same floor as the area it is intended to serve.
 - .2 Accessible to hallways or common areas and access for delivery of large equipment.
 - .3 In multifloored buildings the communication rooms shall be stacked vertically.
 - .4 Avoid locations that may be subject to water infiltration, steam infiltration, humidity exceeding 55%, sources of heat such as direct sunlight, corrosive or adverse environmental conditions and sources of excessive EMI such as machinery.
 - .5 Avoid spaces in or adjacent to mechanical rooms, boiler rooms, washrooms, janitor closets, storage rooms, and loading docks.
- 2.3 Size communication rooms in accordance with the following:
- .1 If the serving area is 500 m² (5000 ft²) or less the room shall be 3.0 m x 2.4 m (10 ft. x 8 ft.).
 - .2 If the serving area is larger than 500 m² (5000 ft²) and less than or equal to 800 m² (8000 ft²) the room shall be 3.0 m x 2.7 m (10 ft. x 9 ft.).
 - .3 If the serving area is larger than 800 m² (8000 ft²) and less than or equal to 1000 m² (10,000 ft²) the room shall be 3.0 m x 3.4 m (10 ft. x 11 ft.).
 - .4 If the serving area exceeds 1000 m² (10,000 ft²) a second communication room shall be required on the same floor.
- 2.4 A separate room shall be provided for the entrance facility. The room shall be located next to or directly below the main equipment room. A space of at least 1.2 m x 1.8 m (4 ft. x 6 ft.) shall be provided for each Access Provider.
- 2.5 A separate room shall be provided for the main equipment room. A space of at least 3 m x 4.6 m (10 ft. x 15 ft.) is required.
- 2.6 Design communication rooms to have fully outward opening, lockable doors that are a minimum of 0.91 m (3 ft.) wide and 2 m (80 in) tall. Access Provider rooms sized at 1.2 m x 1.8 m (4 ft. x 6 ft.) shall have two outward opening 0.91 m (3 ft.) wide and 2 m (6.7 ft.) tall doors.
- 2.7 False ceilings are not permitted.
- 2.8 Ceiling height shall be a minimum of 3 m (10 ft.).
- 2.9 Communication room walls shall extend to the structural ceiling, install high-pressure laminate tile and treat walls and ceiling. Walls shall be 2-hour fire rated.
- 2.10 All walls, floors and ceiling surfaces shall be white in color.
- 2.11 Design access floors in accordance with the following:
- .1 Shall meet the requirements of CISCA.
 - .2 Shall be covered in high-pressure laminate or other durable tile.

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- .3 Have a uniform load capacity of 12 kPa (250 lbs/ft²).
 - .4 Have a concentrated load capacity of 8.8 kN (2000 lbs.).
 - .5 All metal parts of the access floor shall be bonded to ground in accordance with CEC Rule 10-406. A minimum of every fourth pedestal shall be bonded to ground with a 6 AWG wire.
- 2.12 Access floors shall only be installed in data centre applications.
- 2.13 In a multifloored building vertically interconnect communication rooms with a minimum of four 103 mm (4 in) sleeves or conduits. All conduits and sleeves shall be installed with bushing and appropriately rated firestop. Sleeves and conduits entering the communication room shall extend above the floor by 78 mm (3 in) AFF or extend down below the ceiling to 2.4 m (8 ft.) AFF.
- 2.14 Horizontally interconnect multiple rooms on a floor with conduit sized to 40% fill or cable tray that provides equivalent capacity. Regardless of cable counts there shall always be a minimum of two 53 mm (2") conduits or cable tray that provides equivalent capacity between rooms. All conduits shall be installed with bushing and appropriately rated firestop. Conduits entering the communication room shall extend down below the ceiling to 2.4 m (8 ft.) AFF.
- 2.15 Provide a minimum of three 103mm (4") conduits from the property line (location to be recommended by the utility) to the entrance facility designated for Access Provider use. Do not include more than two 90-degree bends in the conduit run between pull points. Never exceed a 90-degree bend. Conduits entering the room shall extend above the floor by 103 mm (4 in) AFF or extend down below the ceiling to 2.4 m (8 ft) AFF. All conduits entering the building shall be sealed with a rubber plug or water plug.
- 2.16 Design communication rooms to have the following power requirements:
- .1 Provide a 15 amp 120-volt duplex convenience receptacle on standard power every 1.8 m (6 ft) around the perimeter walls.
 - .2 In rooms containing active equipment, provide a dedicated communication power panel with Transient Voltage Surge Suppression (TVSS). Identify the panel on the front door with a lamicaid label stating "Communication Panel" and panel designation. If a main UPS is installed in a data centre, all communication power panels shall be powered from that UPS.
 - .3 Provide one 20 amp 120 volt duplex receptacle (5-20RA) and one 20 amp 120 volt duplex twist lock receptacle (L5-20), both black in colour, for each cabinet and rack installed, mounted on the side of the cable tray or below the raised floor where applicable. These receptacles must be fed from the dedicated communication power panel.
 - .4 Provide two 20 amp 120 volt duplex receptacles (5-20RA), black in colour, for every 4ft wide section of backboard installed. These receptacles must be fed from the dedicated communication power panel.

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- 2.17 Design communication room to have the following lighting requirements:
- .1 Minimum of 500 lux (50 fc) measured 0.91 m (3 ft.) above finished floor, in front and behind cabinets installed. Position fixtures to minimize shadows.
 - .2 Do not use dimmer switches.
 - .3 Locate fixtures a minimum of 2.6 m (8.5 ft.) above finished floor.
 - .4 Power for lighting shall not come from the dedicated power panel in the communication room but from standard power.
 - .5 A minimum of 50% the fixtures shall be on emergency power, if available.
- 2.18 Design communication rooms to have a grounding and bonding system as per Specification Section 270526 'Grounding and Bonding for Communication Systems'.
- 2.19 Line a minimum of two walls within the communication room with AC grade or better, void-free plywood, 2.4 m (8 ft) high with a thickness of 19 mm (¾ in). The plywood shall be installed with the 'C' grade facing the wall. Plywood shall be pressure impregnated with fire-retardant chemicals in conformance with CAN/CSA-O80 Series-M and have a flame-spread rating not more than 25. A plywood backboard shall always appear where backbone sleeves enter and leave the communication room, in order to support backbone cables.
- 2.20 Design communication rooms containing active equipment to have the following environmental conditions and controls:
- .1 Maintain continuous and dedicated environmental control (24 hours per day, 365 days per year). Connect HVAC system to emergency power where available.
 - .2 Maintain positive pressure with a minimum of one air change per hour.
 - .3 Dissipate the heat generated by active equipment. Coordinate with the City of Brampton IT department for equipment lists. Regardless of heat loads the cooling provided shall never be less than 0.5 tons/hr (6,000 Btu/hr) in general communication rooms and never less than 1 ton/hr (12,000 Btu/hr) in the main communication room. To include model #?
 - .4 Maintain a temperature of 18 °C to 22 °C.
 - .5 Maintain a relative humidity of 30% to 55%.
- 2.21 Design cabinet installations to be run side by side, with a minimum clearance of 0.91 m (3 ft) in the front and rear of the cabinets. Provide two vertical cable managers in each cabinet. Provide a solid side panel at both ends of a cabinet run, but never between cabinets.
- 2.22 Provide 2 vertical power bars in each floor standing cabinet.
- 2.23 Each cabinet shall have an UPS installed at the bottom of the cabinet. UPS shall be supplied and installed by the City of Brampton. *(See Appendix A for Part Numbers).*

3 **MATERIALS**

3.1 Acceptable manufacturer of all cabinets and associated accessories shall be RF Mote or equivalent.

3.2 Floor standing cabinets shall have the following characteristics:

- .1 Model of cabinet shall be **(See Appendix A for Part Numbers)**
- .2 CSA and UL approved.
- .3 Standard EIA 19" mounting with 44U unit capacity.
- .4 Dimensions: 762 mm (30 in) W x 914 mm (36 in) D x 2109 mm (83 in) H
- .5 #10-32 EIA universal mounting hole spacing.
- .6 Constructed from 11 gauge steel, textured black colour.
- .7 Side panel shall be solid.
- .8 Front door shall be smoked acrylic, with lockable recessed handles.
- .9 Rear door shall be mesh, with lockable recessed handles.
- .10 Cable management shall be a vertical internal ladder style.
- .11 Exhaust fans shall exhaust a minimum of 200 CFM.
- .12 Rear mounting rails shall be installed.

3.3 Vertical power bars shall have the following characteristics:

- .1 CSA and UL approved.
- .2 Rating: 20 amps, 120 volts.
- .3 10 outlets, 20 amps, 120 volts (5-20RA).
- .4 10 ft power cord, with a 20 amp plug (5-20P).
- .5 Built in surge and spike protection.
- .6 Power to the bar shall be switch disabled.

- 3.4 Wall mounted cabinet shall have the following characteristics:
- .1 Model of cabinet shall *(See Appendix A for Part Numbers)*
 - .2 Standard EIA 19" hinged cabinet with 12U, 20U, and 26U unit capacity.
 - .3 Dimensions shall be at minimum: 762 mm (30 in) W x 477 mm (18.75 in) D x 565 mm (22.25 in) H.
 - .4 Extender brackets for cabinets shall be installed *(See Appendix A for Part Numbers)*, to increase depth by 152mm (6 in).
 - .5 Constructed from 11 gauge steel, textured black colour.
 - .6 CSA and UL approved.
 - .7 #10-32 EIA universal mounting hole spacing.
 - .8 Built-in vertical cable management.
 - .9 Provision for two exhaust fans.

4 **FIELD QUALITY CONTROL**

NIL

COPPER BACKBONE CATEGORY 3

1 SCOPE OF WORK

1.1 Include detailed design, manufacturer, supply and installation of communication cabling as described in these performance specifications and summarized in the following elements of the work:

- .1 The scope of work included within the section includes voice end-to-end structured cabling between communication rooms.
- .2 **Supply an End-to-End Certified Structured Cabling System installed by a Systimax Value Added Reseller for the systems described in these specifications.**

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of communication cabling shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
- TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
- TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
- TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware
- TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual
- BICSI – Customer Owned Outside Plant Design Manual

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- 2.2 For every horizontal cable intended for voice, provide two (2) pairs plus 25% spare pairs in the backbone cable between the general communication room and the main communication room or data centre.
- 2.3 No means of splicing shall be used.
- 2.4 Provide 3 m (10 ft) of cable slack within the communication room. All cable slack shall be stored in a neat extended loop or figure of eight within the cable tray or on the backboard. Cable shall not be stored in a bundled loop.
- 2.5 All pairs shall be directly cabled back to a backboard mounted wiring block located within the communication room.
- 2.6 Backbone cable channel link shall not exceed 800 m (2624 ft); this length shall include the cable slack.
- 2.7 Maintain minimum bend radii of four times the cable diameter for twisted pair cable.
- 2.8 Do not exceed the maximum cable pulling force of 110 N (25 lbs) for twisted pair cable.
- 2.9 Neatly bundle cable in logical bundles with minimum 3/4" Velcro or hoop & loop cable tie. Secure cable bundles to horizontal supports and plywood backboard. Plastic tie wraps are not acceptable. Where tie-wraps are used in a plenum space, only UL listed plenum rated tie-wraps shall be used.
- 2.10 Do not deform the cable jacket when using fasteners. Test to see that the fastener is loose enough to rotate easily around the cable when pressed with medium finger pressure.
- 2.11 The twist of the individual pairs shall be maintained up to the point of termination. The maximum amount of untwisting in a pair as a result of termination shall be no greater than 13 mm (0.5 in).
- 2.12 All twisted pair terminations shall use a T568A wire map.
- 2.13 Cables shall be properly supported and protected from damage always and shall be installed in such a way as to ensure that cable will not deform over time.
- 2.14 Where cables are exposed to potential damage, split loom tubing shall be used.
- 2.15 Allow no rough handling, kinking, denting or abrasion of the cable.
- 2.16 Where cables are run in cable tray, neatly bundle and tie-wrap all cables. Separate voice, data and fibre cables into individual bundles.
- 2.17 Vertical riser cable shall be supported a minimum of three (3) times per floor. Supports shall be placed 1 m (3 ft) apart.
- 2.18 Bix Block to be cross connected to 24 Port patch panel in LAN closet with all pairs terminated to Patch Panel.

3 **MATERIALS**

- 3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systemax only.
- 3.2 Obtain components through one source from a single manufacturer.
- 3.3 Voice Backbone cabling shall have the following characteristics:
 - .1 Model of cable shall be **(See Appendix A for Part Numbers)**.
 - .2 Cable shall meet or exceed Category 3 requirements per TIA/EIA-568-B.
 - .3 Conductors: Multipair 24 AWG solid copper
 - .4 UL and CSA rated as CMP/FT6.
 - .6 Insulation: colour coding as per TIA/EIA-568-B
 - .7 Jacket: printed at intervals stating cable code, AWG, manufacturer and length markings, grey in colour.
- 3.4 Wiring Block shall have the following characteristics:
 - .1 Model of wiring block shall be BIX System Kit
 - .2 25 pair capacity
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- 4 **FIELD QUALITY CONTROL**
- 4.1 Refer to 'Testing of Communications Systems' section.

COMMUNICATIONS FIBRE BACKBONE MULTIMODE 550

1 SCOPE OF WORK

- 1.1 Include detailed design, manufacturer, supply and installation of communication cabling as described in these performance specifications and summarized in the following elements of the work:
- .1 The scope of work included within the section includes data end-to-end structured cabling between communication rooms.
- .2 **Supply an End-to-End Certified Structured Cabling System installed by a Systimax Value Added Reseller for the systems described in these specifications.**

2 DESIGN AND PERFORMANCE REQUIREMENTS

- 2.1 Design, manufacturer, supply and installation of communication cabling shall comply with the following standards, unless otherwise stated.
- Canadian Electric Code
 - Ontario Building Code
 - TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
 - TIA/EIA-568-B.1-3 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 3 – Supportable Distances and Channel Attenuation for Optical Fibre Applications by Fibre Type
 - TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
 - TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
 - TIA/EIA-568-B.3 Commercial Building Telecommunication Cabling Standard – Part 3: Optical Fibre Cabling Components Standard
 - TIA/EIA-568-B.3-1 Commercial Building Telecommunication Cabling Standard – Part 3: Optical Fibre Cabling Components Standard – Addendum 1 – Additional Transmission Performance Specifications for 50/125 um Optical Fibre Cables
 - CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
 - TIA/EIA-492AAAB Detail Specification for 50-um Core Diameter/ 125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibre
 - TIA/EIA-492AAAC-A Detail Specification for 850-nm Laser Optimized, 50-um Core Diameter/ 125-um Cladding Diameter Class Ia Grade-Index Optical Fibre
 - BICSI – Telecommunication Distribution Methods Manual

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- BICSI – Information Transport Systems Installation Manual
 - BICSI - Customer Owner Outside Plant Design Manual

- 2.2 In a new building, each general communication room shall be connected to the main communication room or data centre with a fibre backbone cable.
- 2.3 In the case of an extension to an existing building each general communication room shall be connected to the existing main communication room or data centre with a fibre backbone cable, unless stated otherwise by the City of Brampton.
- 2.4 For every forty eight (48) horizontal cables being run to a communication room, provide two (2) multimode strands in the backbone, with a minimum of a twenty four (24) strand cable.
- 2.5 Provide 3 m (10 ft) of cable slack within the communication room. All cable slack shall be stored in a neat extended loop or figure of eight within the cabinet cable management. Cable shall not be stored in a bundled loop.
- 2.6 Maintain a bend radius during installation of fibre cable of 20 times the cable diameter and 10 times the cable diameter after installation.
- 2.7 Do not exceed the maximum cable pulling force of 222 N (50 lbs.) for fibre cable.
- 2.8 Neatly bundle cable in logical bundles with minimum 3/4" Velcro or hoop & loop cable tie. Secure cable bundles to horizontal supports and plywood backboard. Plastic tie wraps are not acceptable.
- 2.9 Do not deform the cable jacket when using fasteners. Test to see that the fastener is loose enough to rotate easily around the cable when pressed with medium finger pressure.
- 2.10 Cables shall be properly supported and protected from damage always and shall be installed in such a way as to ensure that cable will not deform over time.
- 2.11 Vertical riser cable shall be supported a minimum of three (3) times per floor. Supports shall be placed 1 m (3 ft) apart.
- 2.12 Allow no rough handling, kinking, denting or abrasion of the cable.

3 MATERIALS

- 3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systimax only.
- 3.2 Obtain components through one source from a single manufacturer.

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- 3.3 Fibre Backbone Cabling shall have the following characteristics:
- .1 Model of cable shall be **(See Appendix A for Part Numbers)**.
 - .2 Meet or exceed 50/125um requirements per TIA/EIA-568-B.
 - .3 UL and CSA rated as OFNR/FT4, on condition the cable is run within plenum rated corrugated loom tubing at all times.
 - .4 Capable of supporting up to 1 Gigabit fibre channel up to 900 m (1804 ft) at 850 nm.
 - .5 Capable of supporting up to 10 Gigabit fibre channel up to 550 m (1804 ft) at 850 nm.
 - .6 Minimum fibre strand count of 24.
 - .7 Fibre sub-units: colour coding as per TIA/EIA-568-B
 - .8 Jacket: printed at intervals stating cable code, manufacturer and length markings, aqua in colour.
- 3.4 Communication Room Fibre Patch Cords shall have the following characteristics:
- .1 Model of cord shall **(See Appendix A for Part Numbers)**, LC/LC only.
 - .2 Cable characteristics shall match or exceed those of the backbone cable the cord is patching.
 - .3 UL and CSA rated as OFNR/FT4.
 - .4 Jacket: printed at intervals stating cable code, manufacturer, aqua in colour.
 - .5 Factory terminated LC (simplex) connector on both ends.
 - .6 Durability: 500 insertions.
- 3.5 Data Centre Fibre Patch Cords shall have the following characteristics:
- .1 Model of cord shall be **(See Appendix A for Part Numbers)**, LC / LC only.
 - .2 Cable characteristics shall match or exceed those of the backbone cable the cord is patching.
 - .3 UL and CSA rated as OFNR/FT4.
 - .4 Jacket: printed at intervals stating cable code, manufacturer, aqua in colour.
 - .5 Factory terminated LC (simplex) connector on both ends.
 - .6 Durability: 500 insertions.

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- 3.6 Fibre Patch Panels shall have the following characteristics:
- .1 Models of patch panels shall be *(See Appendix A for Part Numbers)*.
 - .2 Shelves: *(See Appendix A for Part Numbers)*- (houses up to 4 modules), *(See Appendix A for Part Numbers)*- (houses up to 8 modules), *(See Appendix A for Part Numbers)*- (houses up to 12 modules),
 - .1 Compatible with standard 19" rack.
 - .2 All plastic materials shall be fire-retardant, UL94V-0 rated.
 - .3 Black in color.
 - .4 Hinged front door
 - .5 Comes with trough cable manager.
 - .6 Top cover panel
 - .3 Modules: *(See Appendix A for Part Numbers)* for communication rooms and for data centres.
 - .1 6 front mounted LC duplex adapters or 24 front mounted LC duplex adapters.
 - .2 Transmission performance characteristics shall match those of LazrSPEED 550.
 - .4 Splices: *(See Appendix A for Part Numbers)*. (for up to 32 splices), *(See Appendix A for Part Numbers)*. (for up to 64 splices), *(See Appendix A for Part Numbers)*. (for up to 96 splices),
- 4 **FIELD QUALITY CONTROL**
- 4.1 Refer to 'Testing of Communications Systems' section.

COMMUNICATION HORIZONTAL CABLING CAT 6

1 SCOPE OF WORK

1.1 Include detailed design, manufacturer, supply and installation of communication cabling as described in these performance specifications and summarized in the following elements of the work:

.1 The scope of work included within the section includes data and voice end-to-end structured cabling between the communication room and the work are

.2 **Supply an End-to-End Certified Structured Cabling System installed by a Systimax Value Added Reseller for the systems described in these specifications.**

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of communication cabling shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 1 – Minimum 4-pair UTP and 4-pair ScTP Patch Cable Bend Radius
- TIA/EIA-568-B.1-2 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 2 – Grounding and Bonding Requirements for Screened Balanced Twisted-Pair Horizontal Cabling
- TIA/EIA-568-B.1-3 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 3 – Supportable Distances and Channel Attenuation for Optical Fibre Applications by Fibre Type
- TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
- TIA/EIA-568-B.2-1 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling

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- TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
 - TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
 - TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware
 - TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5
 - TIA/EIA-568-B.2-6 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 6 – Category 6 Related Component Test Procedures
 - BICSI – Telecommunication Distribution Methods Manual
 - BICSI – Information Transport Systems Installation Manual
- 2.2 All work area jacks shall be housed in wall recessed outlets specifically dedicated to a particular work area, unless a 'MUTOA' section is included in the specification package. When a 'MUTOA' section is included, they shall only be used in open office concepts using modular furniture, unless stated otherwise.
- 2.3 Voice and Data outlet requirements shall be as follows:
- .1 Each workstation shall consist of two data ports, all within one outlet.
 - .2 Each meeting room and conference room shall consist of two data ports, all within one outlet, located on each of the walls within the room.
 - .3 Each office large enough to house a separate meeting table shall contain a second outlet containing two data ports. Located local to the meeting table.
 - .4 Each fax machine, printer station and photocopier station shall consist of two data ports, all within one outlet.
- 2.4 Data ports contained within one outlet shall be arranged as follows:
- 1st data at the top
 - 2nd data on the bottom
- 2.5 No data outlets shall be required for wireless access points, unless a 'wireless access point' section is included in the specification package.
- 2.6 Each jack shall require a dedicated horizontal cable. The splitting of pairs within a cable between different jacks is not permitted.

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- 2.7 All ports shall be directly cabled back to a cabinet mounted patch panel located within the local communication room on the same floor, unless a 'consolidation point' section is included in the specification package.
- 2.8 Provide 1.5 m (5 ft) of horizontal cable slack within the communication room and 3 m (10 ft) of horizontal cable slack within the ceiling space above the work area outlet. All cable slack shall be stored in a neat tie wrapped extended loop or figure of eight. Cable shall not be stored in a bundled loop.
- 2.9 Horizontal cable permanent link shall not exceed 90 m (295 ft.); this length shall include the cable slack. This length is based on a patch cord length not exceeding 5 m (16 ft.). Should the patch cord length exceed 5 m (16 ft.), then the permanent link shall be reduce to match the following equation result:
- Permanent cable length = $102 - (\text{Total combined length of patch cords} * 1.2)$
- 2.10 Outlet may be re-located up to 3 m (10 ft.) at the cost of the contractor if notified prior to installation. This shall not affect the cable slack lengths.
- 2.11 Maintain minimum bend radii of four times the cable diameter for twisted pair cable.
- 2.12 Do not exceed the maximum cable pulling force of 110 N (25 lbs.) for twisted pair cable.
- 2.13 Neatly bundle cable in logical bundles with minimum 3/4" Velcro or hoop & loop cable tie. Secure cable bundles to horizontal supports and plywood backboard. Plastic tie wraps are not acceptable. Where tie-wraps are used in a plenum space, only UL listed plenum rated tie-wraps shall be used.
- 2.14 Do not deform the cable jacket when using fasteners. Test to see that the fastener is loose enough to rotate easily around the cable when pressed with medium finger pressure.
- 2.15 The twist of the individual pairs shall be maintained up to the point of termination. The maximum amount of untwisting in a pair as a result of termination shall be no greater than 13 mm (0.5 in).
- 2.16 The maximum amount of cable jacket that shall be removed as a result of termination shall be no greater than 25 mm (1 in).
- 2.17 All twisted pair terminations shall use a T568A wire map.
- 2.18 Cables shall be properly supported and protected from damaged always and shall be installed in such a way as to ensure that cable will not deform over time.
- 2.19 Where cables are exposed to potential damage, split loom tubing shall be used.
- 2.20 Allow no rough handling, kinking, denting or abrasion of the cable.
- 2.21 Where there are unused port positions in a faceplate, a blank insert shall be provided.
- 2.22 Where cables are run in cable tray, neatly bundle and tie-wrap all cables. Separate voice, data and fibre cables into individual bundles.
- 2.23 Patch cord lengths and counts shall be as follows:

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- .1 Each patch cord length used within a communication room shall be either 0.6 m (2 ft.) or 1.2 m (4ft) or 2.1 m (7ft) long, the appropriate length shall be based on the specific cabinet layout.
 - .2 Each patch cord length used within a work area shall be either 4.2 m (14 ft.) or 7.6 m (25 ft.) long, the appropriate length shall be based on the specific furniture layout.
 - .3 Patch cords shall always be sized to provide a neat and professional installation and include adequate slack for routing through vertical and horizontal cable management.
 - .4 Patch cord counts shall include 10% spare of each length.

3 MATERIALS

- 3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systimax only.
- 3.2 Obtain components through one source from a single manufacturer.
- 3.3 Voice and Data Horizontal cabling shall have the following characteristics
 - .1 Model of cable shall be **(See Appendix A for Part Numbers)**.
 - .2 Cable shall meet or exceed Category 6 requirements per TIA/EIA-568-B.
 - .3 Conductors: 4-pair 23 AWG solid copper
 - .4 UL and CSA rated as CMP/FT6.
 - .5 Capable of supporting up to 1 Gigabit Ethernet.
 - .6 Insulation: colour coding as per TIA/EIA-568-B
 - .7 Jacket: printed at intervals stating cable code, AWG, manufacturer and length markings, blue in colour for data and white in color for voice.
- 3.4 Data and Voice Work Area Jacks shall have the following characteristics:
 - .1 Model of jack shall be **(See Appendix A for Part Numbers)**.
 - .2 Meet or exceed Category 6 requirements per TIA/EIA-568-B.
 - .3 8-pin, RJ45
 - .4 All plastic materials shall be fire-retardant, UL94V-0 rated.
 - .5 Data jacks shall be blue in color and voice jacks shall be slate grey.
 - .6 Durability: 750 insertions

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- 3.5 Data and Voice Patch Cords shall have the following characteristics:
- .1 Model of cord shall be *(See Appendix A for Part Numbers)*.
 - .2 Meet or exceed Category 6 requirements per TIA/EIA-568-B.
 - .3 Conductors: 4-pair 24 AWG stranded copper
 - .4 UL and CSA rated as CMR/FT4.
 - .5 Insulation: colour coding as per TIA/EIA-568-B
 - .6 Jacket: printed at intervals stating cable code, AWG, manufacturer, grey in colour for voice and blue in colour for data.
 - .7 Factory terminated RJ45 connector on both ends.
 - .8 Durability: 750 insertions.
- 3.6 Copper Data and Voice Patch Panels shall have the following characteristics:
- .1 Model of patch panel shall be *(See Appendix A for Part Numbers)*.
 - .2 48-port, 2U or 24-port, 1U
 - .3 Compatible with standard 19" rack.
 - .4 Jacks shall meet or exceed Category 6 requirements per TIA/EIA-568-B. Category 6A for wireless.
 - .5 Jacks shall be 8-pin, RJ45.
 - .6 All plastic materials shall be fire-retardant, UL94V-0 rated.
 - .7 Jacks shall be (See Appendix in C for colours).
 - .8 Durability: 750 insertions.
- 3.7 Wall faceplates shall be *(See Appendix A for Part Numbers)*.2, 4-port, white in colour.
- 3.8 Furniture faceplate shall be *(See Appendix A for Part Numbers)*.2, 4-port, white in colour.
- 4 **FIELD QUALITY CONTROL**
- 4.1 Refer to 'Testing of Communications Systems' section.

COMMUNICATION CONSOLIDATION POINTS

1 SCOPE OF WORK

- 1.1 Include detailed design, manufacturer, supply, installation and inspection of consolidation points as described in these performance specifications and summarized in the following elements of the work:
- .1 The scope of work included within the section includes consolidation point configurations within a horizontal cable run.

2 DESIGN AND PERFORMANCE REQUIREMENTS

- 2.1 Design, manufacturer, supply and installation of consolidation points and related items shall comply with the following standards, unless otherwise stated:
- Canadian Electric Code
 - Ontario Building Code
 - TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
 - TIA/EIA-568-B.1-1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 1 – Minimum 4-pair UTP and 4-pair ScTP Patch Cable Bend Radius
 - TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
 - TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
 - TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
 - TIA/EIA-568-B.2-1 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling
 - TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
 - TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
 - TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware

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- TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5
 - TIA/EIA-568-B.2-6 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 6 – Category 6 Related Component Test Procedures
 - TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
 - TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
 - CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
 - BICSI – Telecommunication Distribution Methods Manual
 - BICSI – Information Transport Systems Installation Manual
 - CISCA – Ceiling and Interior Systems Construction Association

- 2.2 Consolidation points shall be located in fully accessible and permanent locations. Consolidation point must not be located in an obstructed area.
- 2.3 The consolidation point shall be sized to have a minimum of 40% spare capacity for future additions.
- 2.4 The consolidation point shall be located at least 15 m (50 ft) from the local communication room and horizontal cross-connect.
- 2.5 A consolidation point located within the ceiling space or raised access floor shall follow the following rules:
- .1 All items installed within a plenum space shall be UL listed as plenum rated or be completely enclosed within a plenum rated container.
 - .2 Ceiling space or raised access floor space must be fully accessible without moving building fixtures, equipment, or heavy furniture or disturbing building occupants. Heavy furniture is defined as 45 kg (100 lb) or more as per TIA/EIA-569-B.
 - .3 The ceiling or floor tile shall be clearly and permanently labelled as concealing a consolidation point.
 - .4 Shall not contain any active equipment.
 - .5 Shall be bonded to the nearest communication grounding busbar with a minimum 6 AWG.
 - .6 Cable entering and exiting the consolidation point shall pass through plenum rated fire foam.
 - .7 Shall be located along side a main communication pathway such as a cable tray.

-
- 2.6 When consolidation points are located within the office space they shall be mounted to a permanent building structure.
- 2.7 A consolidation point shall only be used for making direct connections to communication outlets. A consolidation point shall never be used as a cross-connect location, for patching, or for direct connections to active equipment with patch cords.
- 3 **MATERIALS**
- 3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systimax only.
- 3.2 Obtain components through one source from a single manufacturer.
- 3.3 Consolidation points shall have the following characteristics:
- .1 Model of consolidation point shall be M48 Zone Wiring Box only.
 - .2 Accommodates up to 48 M-series jacks.
 - .3 UL listed for plenums spaces
 - .4 Twelve 19 mm (0.75 inch) knockouts for use with conduits.
 - .5 Removable cover.
- 4 **FIELD QUALITY CONTROL**
- 4.1 Refer to 'Testing of Communications Systems' section.

COMMUNICATION WIRELESS ACCESS POINT OUTLETS CAT6A

1 SCOPE OF WORK

- 1.1 Include detailed design, manufacturer, supply, installation and inspection of wireless systems as described in these performance specifications and summarized in the following elements of the work:
- .1 The scope of work included within the section includes wireless access point outlet configurations.

2 DESIGN AND PERFORMANCE REQUIREMENTS

- 2.1 Design, manufacturer, supply and installation of wireless access point outlet and related items shall comply with the following standards, unless otherwise stated:
- Canadian Electric Code
 - Ontario Building Code
 - TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
 - TIA/EIA-568-B.1-1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 1 – Minimum 4-pair UTP and 4-pair ScTP Patch Cable Bend Radius
 - TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
 - TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
 - TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
 - TIA/EIA-568-B.2-1 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling
 - TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
 - TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
 - TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware
 - TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5

- TIA/EIA-568-B.2-6 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 6 – Category 6 Related Component Test Procedures
- TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
- TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual
- Cisca – Ceiling and Interior Systems Construction Association

- 2.2 All horizontal and backbone cabling related to wireless access points shall confirm to the appropriate specification section included in this package.
- 2.3 Horizontal cable permanent link shall not exceed 80 m (262 ft), this is due to the extended length of the access point patch cord.
- 2.4 Two data outlets shall be installed per wireless access point.
- 2.5 Data outlets in 2.4 shall be terminated to a SYSTIMAX 24-port patch panel in the local LAN room, used specifically for wireless outlet data drops. (W-01, W-02, etc)
- 2.6 No power outlet shall be required; all power to the access point shall be via Power over Ethernet (PoE) – (by others).
- 2.7 Each outlet shall be located above the T-bar ceiling mounted to the structural ceiling and consist of two data jacks housed in a two-port metallic faceplate mounted to a metallic single gang surface mount box. One 19 mm (0.75 in) grommet lined hole shall be used for all cables.
- 2.8 Every effort shall be made to enclose all non-plenum rated items within the metallic box.
- 2.9 Two outlets in a single assembly shall be placed in a cell like pattern to cover the entire usable area of the building (usable area does not include washrooms, changing rooms, stairs, electrical or mechanical rooms). Spacing of these outlets shall be based on the following table:

	Cell diameter of a 54 Mbps access point
Open space (warehouse)	46 m (151 ft)
Semi Open area (cubicle area)	32 m (105 ft)
Closed Office	22 m (72 ft)

- 2.10 One 4.2 m (14 ft) or 7.6 m (25 ft) plenum rated patch cord shall be included for every outlet. The appropriate length shall be based on the specific location of the access point, and as dictated by the City of Brampton IT division.

3 **MATERIALS**

- 3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systemax only.
- 3.2 Obtain components through one source from a single manufacturer.
- 3.3 Data horizontal cabling shall be **CAT6A** all other horizontal cable specified in other sections.
- 3.4 Patch cord shall match performance characteristics specified in other sections, with the following physical differences:
 - .1 Two (2) 4.2 m (14 ft) or 7.6 m (25 ft) in length
 - .2 UL and CSA rated as CMP/FT6.
 - .3 Red in color

4 **FIELD QUALITY CONTROL**

- 4.1 Refer to 'Testing of Communications Systems' section.

COMMUNICATION MUTOA OUTLETS

1 SCOPE OF WORK

1.1 Include detailed design, manufacturer, supply, installation and inspection of Multi-User Telecommunications Outlet Assembly (MUTOA) as described in these performance specifications and summarized in the following elements of the work:

- .1 The scope of work included within the section includes MUTOA configurations within a work area.

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of MUTOAs and related items shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 1 – Minimum 4-pair UTP and 4-pair ScTP Patch Cable Bend Radius
- TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
- TIA/EIA-568-B.2-1 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling
- TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
- TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
- TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware
- TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5

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- TIA/EIA-568-B.2-6 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 6 – Category 6 Related Component Test Procedures
 - TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
 - TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
 - CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
 - BICSI – Telecommunication Distribution Methods Manual
 - BICSI – Information Transport Systems Installation Manual
- 2.2 MUTOA's shall be used in open office concepts, for modular furniture designs only, unless stated otherwise.
- 2.3 MUTOA's shall be located in fully accessible locations on building columns or permanent walls. MUTOA's shall never be installed in ceiling spaces, under access floors or in obstructed areas.
- 2.4 The MUTOA shall be sized to have a minimum of 40% spare capacity for future additions.
- 2.5 A MUTOA shall only be used for making direct connections to work area equipment. A MUTOA shall never be used as a cross-connect location.
- 2.6 Patch cords connected to a MUTOA shall never exceed 22 m (72 ft) in length; this is based on a horizontal cable length not exceeding 70 m (230 ft). Refer to the horizontal cable section of the specification for specifics.
- 3 **MATERIALS**
- 3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systemax only.
- 3.2 Obtain components through one source from a single manufacturer.
- 3.3 MUTOA shall have the following characteristics:
- .1 Model of MUTOA shall be M224 Zone Wiring Box only.
 - .2 Accommodates up to 24 M-series jacks.
 - .3 Removable cover.
 - .4 White in colour.
- 4 **FIELD QUALITY CONTROL**
- 4.1 Refer to 'Testing of Communications Systems' section.

TESTING OF COMMUNICATIONS SYSTEMS

1 SCOPE OF WORK

- 1.1 Include detailed inspection, testing and administration of communication system as described in these performance specifications and summarized in the following elements of the work:
- .1 The scope of work included within the section includes testing, identification and administration of an end-to-end structured cabling system and its pathways and spaces.

2 DESIGN AND PERFORMANCE REQUIREMENTS

- 2.1 Inspection, testing and administration of communication system shall comply with the following standards, unless otherwise stated:
- Canadian Electric Code
 - Ontario Building Code
 - TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
 - TIA/EIA-568-B.1-1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 1 – Minimum 4-pair UTP and 4-pair ScTP Patch Cable Bend Radius
 - TIA/EIA-568-B.1-2 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 2 – Grounding and Bonding Requirements for Screened Balanced Twisted-Pair Horizontal Cabling
 - TIA/EIA-568-B.1-3 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 3 – Supportable Distances and Channel Attenuation for Optical Fibre Applications by Fibre Type
 - TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
 - TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
 - TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
 - TIA/EIA-568-B.2-1 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling
 - TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
 - TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination

- TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware
- TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5
- TIA/EIA-568-B.2-6 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 6 – Category 6 Related Component Test Procedures
- TIA/EIA-568-B.3 Commercial Building Telecommunication Cabling Standard – Part 3: Optical Fibre Cabling Components Standard
- TIA/EIA-568-B.3-1 Commercial Building Telecommunication Cabling Standard – Part 3: Optical Fibre Cabling Components Standard – Addendum 1 – Additional Transmission Performance Specifications for 50/125 um Optical Fibre Cables
- TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
- TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Infrastructure Standard
- TIA/EIA-942 Telecommunications Infrastructure Standard for Data Centres
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual
- BICSI - Customer Owner Outside Plant Design Manual

3 **MATERIALS**

NIL

4 **FIELD QUALITY CONTROL**

4.1 Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests.

4.2 Test procedures and test equipment shall comply with the following standards (in their latest draft including all addendums):

- .1 TIA/EIA-568-B
- .2 TIA/EIA TSB-140
- .3 TIA/EIA-526-14-A
- .4 TIA/EIA-526-7-A

- 4.3 The copper test equipment testing Category 5e cable shall comply with the accuracy requirements for Level III field testers and Category 5e cabling as defined in the above standards. All software shall be the latest versions, and licensed.
- 4.4 The copper test equipment testing Category 6 cable shall comply with the accuracy requirements for Level III field testers and Category 6 cabling as defined in the above standards. All software shall be the latest versions, and licensed.
- 4.5 The copper test equipment testing Category 6A cable shall comply with the accuracy requirements for Level IIIe field testers and Category 6A cabling as defined in the above standards. All software shall be the latest versions, and licensed.
- 4.6 The optical fibre test equipment shall comply with the accuracy requirements for field testers and fibre optic cabling as defined in the above standards. The OTDR shall operate within the range of 850 nm +/- 30 nm and 1300 nm +/- 20 nm for multimode fibre and 1310 nm +/- 10 nm and 1550 nm +/- 20 nm for singlemode fibre testing.
- 4.7 All installed cable runs shall be tested and must pass the requirements of the standards defined above. Any failing link shall be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The passing result of the tests for all links shall be provided in the test results documentation.
- 4.8 All Category 5e, 6 and 6A cable links shall be tested for channel link performance and the following parameters:
- T568A wire map for continuity on all pairs
 - Length – using an accurate NVP value, the pair with the longest electrical delay shall be used for the maximum length.
 - Insertion Loss
 - NEXT Loss must be tested from both ends of the cabling
 - ELFEXT must be tested from both ends of the cabling
 - Propagation delay and delay skew
 - Return Loss must be tested from both ends of the cabling
 - PSNEXT must be tested from both ends of the cabling
 - Power Sum ELFEXT must be tested from both ends of the cabling
 - ANEXT must be tested from both ends of the cabling (for Cat 6A only)
- 4.9 All fibre cable shall be tested before installation while still on the reel for attenuation at both 850 nm and 1300 nm for multimode and 1310 nm and 1550 nm for singlemode to ensure that it meets or exceeds the manufacturer stated performance. The contractor shall provide a soft copy of the test results to the Communications Consultant. The Communications Consultant must approve this report prior to any installation activity.
- 4.10 All fibre cable links shall be tested for channel link performance for the following parameters:
- End-to-end attenuation tested at both 850 nm and 1300 nm for multimode to ensure predicted system performance.
 - A-B Polarity where duplex connectors are used
 - OTDR signature trace documentation for as-built records
- 4.11 Testing will be considered completed once records show that all installations meet the 100% pass rate.

SYSTIMAX STANDARDS SPECIFICATION GUIDELINES

1.0 TEST RESULTS

- 1.1.1 Cabling Contractor is required to submit test results in native tester format to the City of Brampton. Cabling Contractor is to provide the software required to view the results.
- 1.1.2 The report should be divided into sections by building floors
- 1.1.3 The report should indicate for each cable when it was tested successfully, the result, and the length.
- 1.1.4 The entire report must be signed by an authorized person for the Communications Cabling Contractor and a Registered Communication Distribution Designer (RCDD) at the end of the project.
- 1.1.5 The test result documentation is to be submitted to the City of Brampton for review no later than 5 working days following the completion of the installation.

2.0 AS-BUILT DRAWINGS

- 2.1.1 Communications Cabling Contractor is required to provide as-built drawings of the cable installation for all cabling included in this specification. All drawings to be provided to City of Brampton at the end of the project for any changes due to on-site conditions.
- 2.1.2 The as-built drawings are to include, but are not limited to, the following:
 - 1. Cable numbers on the floor plans.
 - 2. Changes on the floor plans.
 - 3. Cable routing on the floor plans.
 - 4. Rack Elevation drawings and changes.
 - 5. Backboard Elevation drawing and changes.
 - 6. Riser Routing Drawing.
- 2.1.3 Communications Cabling Contractor to provide one (1) soft copy in AutoCAD 2014 format and six (6) plotted copies for the City of Brampton after the City of Brampton 's final review and acceptance of the drawings.
- 2.1.4 Within 30 working days after approval, the Communications Cabling Contractor is to distribute one copy of the plotted copies to each of the telecommunications closets

3.0 CHANGE NOTICES

- 3.1.1 All change notice pricing will include, by line item, a detailed breakdown including :
 - 1. Part number
 - 2. Unit cost
 - 3. Labour Units
 - 4. Labour Cost as per this document.
 - 5. HST
 - 6. Mark-ups for overhead and profit
 - 7. Total Price for the change notice
- 3.1.2 Labour cost and mark-ups will apply for the duration of the project.
- 3.1.3 Change Notices are to reference the City of Brampton Change Notice Number or Site Instruction. Work is not to proceed without prior approval.

4.0 MANDATORY REQUIREMENTS

- 4.1.1 Cabling contractor must be registered as CommScope SYSTIMAX Value Added Re-Seller (VAR) (Prestige, Authorized, Authorized Installer) as of the date of the Tender closing.
- 4.1.2 Provide a proof of company's CommScope's SYSTIMAX Solutions VAR Certification including expiry date and duration of experience.

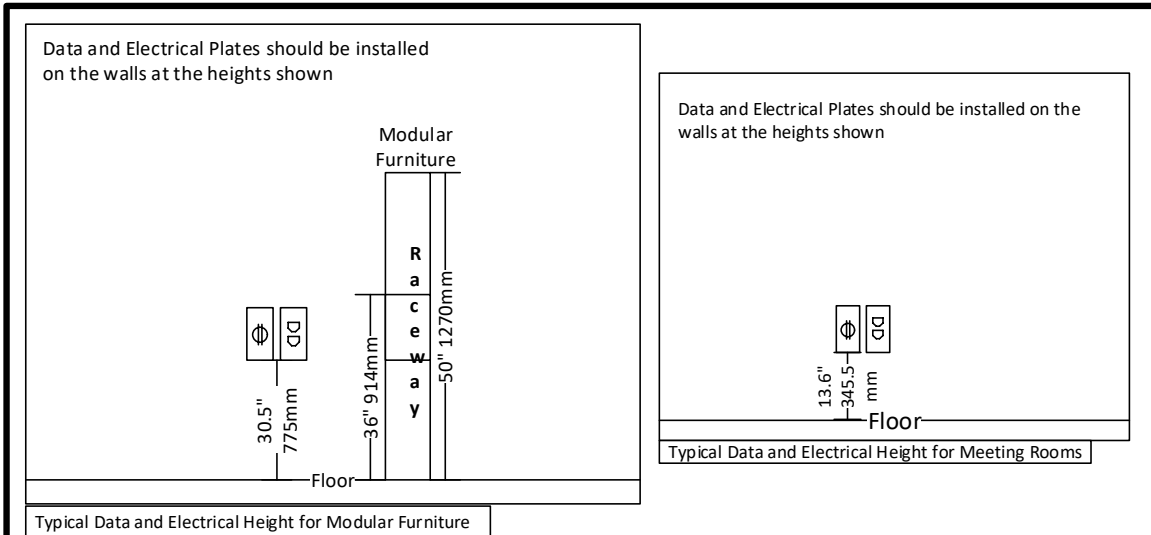
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- 4.1.3 Provide a copy of SYSTIMAX SCS Design & Engineering Certification including expiry date for each Project Manager designated to work on the City of Brampton sites.
 - 4.1.4 Provide a copy of SYSTIMAX SCS Installation and Maintenance including expiry date for each installer designated to work on the City of Brampton sites.
 - 4.1.5 Provide a copy of RCDD's Certification including expiry date for each designer designated to work on the City of Brampton site. Must be able to sign off on as-built documentation.
 - 4.1.6 A 20 Year Systimax Certification Warranty on cabling shall be provided to the City of Brampton no later than 30 working days following the completion of the installation.

APPENDIX A – APPROVED MATERIALS LIST

Section	Material	Manufacture	Model
270528			
	Cable Tray	Flextray	
	Cable Tray	Cablofil	
	Sling Support System	Erico Caddy Cablecat	
271100			
	Floor standing cabinets	RF Mote	RFM-303083
	Floor standing cabinets	RF Mote	RFM-303059
	Wall mounted cabinet	RF Mote	RFM-3022-WM
	Wall mounted cabinet	RF Mote	RFM-3036-WM
	Wall mounted cabinet	RF Mote	RFM-3048-WM
	6" Extender Brackets	RF Mote	RFM-6X-WM
	6" Extender Brackets	RF Mote	RFM-6X-WM-36
	6" Extender Brackets	RF Mote	RFM-6X-WM-48
	UPS	APC	SMX1500RM2UNC (City Supplied and Installed)
271313			
	Voice Backbone Cable	Systemax	Plenum 2010
	Wiring Block	Belden	BIX
271323			
	Fibre BackBone Cable	Systemax	LazrSPEED 550 - Plenum rated
	Fibre Patch Panel	Systemax	600G2-1U-MOD-SD-360
	Fibre Patch Cords	Systemax	FEXLCLC42-MXF0XX
	Shelves	Systemax	360G2-1U-MOD-SD
	Shelves	Systemax	360G2-2U-MOD-SD
	Shelves	Systemax	360G2-4U-MOD-SD
	Modules	Systemax	360DP-12LC-LS
	Modules	Systemax	360DP-24LC-LS
	Splices	Systemax	RS-2AF-16SF
	Splices	Systemax	RS-4AF-16SF
	Splices	Systemax	SW-6AF-16SF
271513			
	Horizontal Cable (Data)	Systemax	GigaSPEED XL 2071E
	Horizontal Cable (WIRELESS)	Systemax	GigaSPEED XL 2091B / Alternate 2091SD
	Jack (Data) / Jack (Wireless)	Systemax	MGS400 (DATA) / MGS600-XXX (WIRELESS)
	Patch Cords Floor Racks for wireless see 271544	Systemax	CPC3312-0xFyyy
	Patch Cords Wall Mounts for wireless see 271544	Systemax	MINO6-XX
	Patch Panel	Systemax	CPP-UDDM-M-1U-24 / CPP-UDDM-M-2U-48
	Data Jacks for M2000	Systemax	MGS400-XXX

Section	Material	Manufacture	Model
271513	Wall faceplates	Systemax	M12LE-266
cont.	Wall faceplates	Systemax	M13LE-266
	Wall faceplates	Systemax	M16LE-266
	Wall faceplates	Systemax	M13SP
	Wall faceplates	Systemax	M16SP
	Furniture faceplate	Systemax	M13C-262
271520			
	Consolidation point	Systemax	M48 Zone Wiring Box
271544			
	Dual Port Surface Box	Systemax	M202 Plenum SMB-262
	Patch Cable for Ceiling	Systemax	CPCSSY2-07F015 (Plenum Rated)
	Patch Cable for Ceiling	Systemax	CPCSSY2-07F025 (Plenum Rated)
	Patch Cable for Ceiling	Systemax	CCA-CAT6A-PLENUM (Plenum Rated)
	Patch Cords Floor Racks	Systemax	CPCSSX2- (Red)
	Patch Cords Wall Mounts	Systemax	CO199K2- (Red)
271545			
	MUTOA	Systemax	M224 Zone Wiring Box
OTHER	Wire Mold	Wire Mold	V750 (Colour to match wall being installed on)

APPENDIX C – OUTLET MOUNTING HEIGHTS AND PATCH CABLE COLOURS



All Cables terminating into patch panels are to be Blue in Colour with the exception of security cabling.



**Red Patch Cables will be used for:
Wireless and UPS (Red Jacks in M2000 Patch Panel)**



**Green Riser/Patch Cables will be used for:
Security ONLY**



**Blue Patch Cables will be used for:
All Data Drops (Computers)**



**Grey Patch Cables will be used for:
All Voice related Devices including Avaya Gateway**



**Orange Patch Cables will be used for:
All Monitoring Devices
BAS, FMC, Brine, Fuel, Electric Charging, People Counter etc.
(Orange Jacks in M2000 Patch Panel)**



**Purple Patch Cables will be used for:
AV Devices
(Purple Jacks in M2000 Patch Panel)**

Integrated Audio-Visual System

PART 1 - GENERAL**1.1 Related Documents**

- .1 Drawings and general provisions of the Contract, including General and Particular Conditions and Division 01 Specification Sections, apply to this Section.

1.2 Summary

- .1 Section includes general design requirements, administration topics and installation for audiovisual systems.
- .2 Related Sections:
 - .1 Section 260500 - Basic Electrical Materials and Methods.
 - .2 Section 260519 – Low-Voltage Electrical Power Conductors and Cables.
 - .3 Section 260533 - Raceways and Boxes for Electrical Systems.
 - .4 Section 260536 - Cable Trays for Electrical Systems.
 - .5 Section 262726 - Wiring Devices.
 - .6 Section 264313 - Surge Protection for Low-Voltage Electrical Power Circuits.
 - .7 Section 271005 – Common Clauses for Structured Cabling (TIA).
 - .8 Section 271055 - Identification for Communications Systems (TIA).
 - .9 Section 271105 - Communications Equipment Room Fittings (TIA).
 - .10 Section 271505 - Communications Horizontal Cabling (TIA).
 - .11 Section 272000 - Data Communications.
 - .12 Section 274132 – IP-Based Television System (IPTV).
 - .13 Section(s) listed in Paragraph 1.1 B above.
- .3 Names, terminologies and definitions of the Contract shall prevail.
- .4 Refer to Contract SCHEDULES and Agreement for definitions and specific dates of Contract Time and durations/intervals for Submittals. In case any discrepancy between the provisions of this Section and the Contract provisions, notify Client immediately.

1.3 Reference Standards

- .1 Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean reference to the latest printed edition of each.
- .2 All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references.
 - .1 UL: Underwriters Laboratories.

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- .2 EIA: Electronic Industries Alliance.
- .3 ECIA: Electronic Components Industry Association.
- .4 TIA: Telecommunications Industry Association.
- .5 ISO: International Standards Organization. IEC 60268-16, Sound system equipment - Part 16: Objective rating of speech intelligibility by speech transmission index.
- .6 AVIXA (formerly InfoComm International)
 - .1 ANSI/Infocomm A102.01:2017 Audio Coverage Uniformity in Listener Areas.
 - .2 ANSI/Infocomm 2M: 2010, Standard Guide for Audiovisual Systems Design and Coordination.
 - .3 ANSI/Infocomm 3M: 2011, Projected Image System Contrast Ratio.
 - .4 ANSI/InfoComm 10:2013, Audiovisual Systems Performance Verification.
 - .5 ANSI/InfoComm 4:2012, Audiovisual Systems Energy Management.
 - .6 ANSI/InfoComm V202.01:2016 Display Image Size for 2D Content in Audiovisual Systems.
 - .7 AVIXA/Infocomm F502.01:2018 Rack Building Audiovisual Systems
 - .8 InfoComm F501.01:2015 Cable Labeling for Audiovisual Systems (CLAS).
 - .9 InfoComm Dashboard for Controls.
- .7 ANSI X3T12: for FDDI and CCDI.
- .8 IEEE 802.3 – Carrier Sense Multiple Access/Collision Detection Access Methods (Ethernet).
- .9 Society of Motion Picture and Television Engineers (SMPTE).
- .10 Electrical equipment, devices and components shall comply with the requirements of EMC:
 - .1 EN 61000-6-1, Electromagnetic compatibility (EMC). Generic standards. Immunity for residential, commercial and light-industrial environments.
 - .2 EN 61000-6-3, Electromagnetic compatibility (EMC). Generic standards. Emission for residential, commercial and light-industrial environments.
- .11 Information Technology equipment, devices and components shall comply with the appropriate Class for project environment as per requirements of:
 - .1 EN 55032, Electromagnetic compatibility of multimedia equipment. Emission Requirements. EN 55024, Information technology equipment. Immunity characteristics. Limits and methods of measurement.
- .12 Code of Federal Regulations
 - .1 47 CFR - Telecommunication, Chapter I - Federal Communications Commission, Part 15 - "Radio Frequency Devices."

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- .13 All electrical works shall comply with applicable local regulations and code requirements of Authorities Having Jurisdiction. Refer also to Division 26 Section "Basic Electrical Materials and Methods".
- .3 All A/V systems designed and installed shall meet the most current version of the following Standard(s), including assisted listening systems, visual access and accommodations. The Contractor shall ensure all relevant requirements are addressed.
 - .1 Americans with Disabilities Act (ADA).
- .4 All A/V equipment (such as display units) shall be "ENERGY STAR qualified" products or equivalent international certification program wherever possible. They shall carry the latest applicable version of ENERGY STAR label or equivalent.
- .5 Local regulations and codes. These are to have precedence over the Standards where enforced and relevant.
- .6 Equipment and system shall comply with the following Standard:
 - .1 UL 813 - Commercial Audio Equipment or
 - .2 IEC 60268 – Sound System Equipment and BS 6259 - Code of practice for the design, planning, installation, testing and maintenance of sound systems.
- .7 Comply with the latest issue of:
 - .1 NFPA 72, "National Fire Alarm Code".

1.4 Definitions and Abbreviations

- .1 Definitions
 - .1 Gain is a measure of a screen's reflectivity – i.e. how much light the screen reflects, and ultimately how well the screen redirects light from the projected image to the audience. It is measured from the viewing angle where the screen reflects the most light, which is directly in front and at a 90 degree angle to the screen. Gain is measured relative to a block of magnesium carbonate which is a very white chemical coating that serves as the standard for 1.0 gain. A number higher than 1.0 indicates greater brightness. Gain shall be determined in accordance with SMPTE RP 94- 2000.
 - .2 Viewing angle: Angle from perpendicular of screen center at which the brightness of the image is half of its maximum potential.
 - .3 Keystone: Distortion of projected image when the projector is not aligned perpendicularly to the projection screen.
 - .4 Reference to "U.L. (Materials Construction) Standards" shall mean the "Standards for Safety" published by Underwriters Laboratories, Inc.
 - .5 SYSTEM: The Audio-Visual System to which these Specifications apply.

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- .6 Scaler: A device that converts video signals from one resolution or frame rate to another; usually up-scaling or up-converting a video signal from a low resolution to one of higher resolution.
 - .7 Line driver: A signal amplifier used to extend an audio or video signal over extended distances. Similar in function to a distribution amplifier, but with one input and one output
 - .8 Extender: similar to the line driver but operates in transmitter and receiver pairs to allow long distance transmission of digital signals via twisted pair or fiber optic cable
- .2 Abbreviations
- .1 BMDS: Background Music Distribution System.
 - .2 CEC: Consumer Electronics Control
 - .3 DSP: Digital Signal Processing
 - .4 dB: Decibels
 - .5 EDID: Extended display identification data
 - .6 Eq: Equalizer
 - .7 HDCP: High-bandwidth Digital Content Protection
 - .8 HDMI: High-Definition Multimedia Interface
 - .9 SMTP: Simple Mail Transport Protocol.
 - .10 SNPP: Simple Network Paging Protocol.
 - .11 SPL: Sound Pressure Level
 - .12 STC: Sound Transmission Class
 - .13 STI: Speech Transmission Index

1.5 Scope of Work

- .1 The works detailed within the Contract Documents have been specified to meet certain requirements for performance, appearance, and cost. It shall be the responsibility of the Contractor to implement the guidelines and requirements contained in the Contract Documents and translate them into a complete design package containing all elements necessary for a complete, operational, and functionally integrated Audiovisual System(s).
- .2 The Contractor shall provide audiovisual systems design, engineering, and installation within designated spaces of the Project as shown on Drawings. The Contractor shall provide, based on these specifications, associated design drawing and contract document, all equipment, material, labor and services required to construct and install the AV including, but not limited to:
 - .1 Design of AV systems for a complete functioning system.
 - .2 Equipment, materials, labor and services for the installation of the AV system.

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- .3 Equipment, materials, labor and services, not specifically mentioned or shown, which may be necessary for the installation of the AV system, including the newer or upgraded model.
- .4 Hardware as specified for the system and any hardware that is specific to the Contractor system.
- .5 Software application and licensing and any other software that may be required to make the system fully operational as specified including the provision and configuring of IP addresses.
- .6 Installation, setup, and programming of the system hardware and software.
- .7 Final connection of hardware to power, infrastructure termination and patch cords connecting system equipment to the data outlets and other network communication equipment and grounding per TIA/EIA standards and best practices.
- .8 Design Submittals, Operation and Maintenance Manuals and As-built documentation for all AV hardware and software components.
- .9 Test plans, system testing and commissioning.
- .10 System warranty as specified herein.
- .11 Training as specified herein.
- .12 Maintenance and support as specified herein.
- .3 The Contractor shall integrate the AV system with other building systems. Integration shall include software, licensing, and hardware components as described below and in this section.
- .4 The Contractor shall integrate/interface the AV System with other building systems. Integration shall include software and hardware components as described below and in this section.
- .5 The Contractor shall provide a Fire Alarm interface and Emergency evacuation override to mute all sound and allow playback of Emergency Evacuation Messages during fire alarms. Refer to the Fire Alarm drawings and specifications for details. Coordinate exact functionality with the **Owner and the Authorities having Jurisdiction.**
- .6 ~~Works Specified Elsewhere~~
 - .1 Installation of raceway, pull-boxes, plywood backboards and floor-boxes. Coordination shall be required within the design to verify the appropriate raceways are in place.
 - .2 Installation and termination of data network systems.
 - .3 Civil works in connection with the audiovisual system such as cutting, patching and painting of walls.

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1.6 Products and Work by Others/Coordination

- .1 The Owner may separately purchase and/or provide certain equipment and miscellaneous items that will be installed during the course of the installation process. Such items may not be indicated in the documents. Contractor shall coordinate with the Owner and his Suppliers when considering:
 - .1 Structured communications system cabling, termination, identification and testing.
 - .2 Provision and installation of phone systems, computer hardware, racks/cabinets and related networking software and equipment.
 - .3 Active communication and data processing equipment.
 - .4 Fiber optic cabling infrastructure.
 - .5 Provision and installation of a Virtualized Servers Environment.
 - .6 Provision and installation of UPS in communications rooms.
 - .7 Communications grounding busbars and grounding wires connecting to the main building earth electrode system.
 - .8 Dedicated power panels, ground busbars, circuits, floor boxes and utility outlets.
 - .9 Installation and finishing of plywood backboards.
 - .10 Building mechanical ductwork, cooling/heating system and environmental control sensors.
 - .11 Communications pathway devices such as cable trays, conduits, conduit sleeves, and penetrations in walls and floors.
 - .12 Installation of raceway, pull-boxes, plywood backboards and floor-boxes. Coordination shall be required within the design to verify the appropriate raceways are in place.
- .2 Accordingly, Contractor shall:
 - .1 Meet jointly with representatives of above systems, Contractors, Operators, Engineer and Owner to exchange information and agree on details of project implementation, equipment arrangements and interface, etc.
 - .2 Record agreements reached in meetings and distribute record to participants.
 - .3 Adjust arrangements and locations of equipment in technical rooms to accommodate and optimize arrangement and ensure necessary interface with other systems.
 - .4 Coordinate with related trades to schedule the works and ensure a complete installation in accordance with the Project Schedule.

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- .5 Coordinate with the HVAC design to ensure optimum environmental conditions are maintained as per A/V equipment manufacturers' recommendations:
 - .1 Identify the ambient temperature and relative humidity operating ranges required to prevent equipment damage.
 - .2 Identify the air conditioning requirements, expressed in BTU per hour, based on adequate dissipation of generated heat to maintain required room and equipment standards.
- .6 Coordinate all IP device requirements with the Project Data Network and to the approval of the Owner / Engineer.
- .7 Coordinate with the Electrical design to ensure providing the power requirement for the selected equipment as per A/V equipment manufacturers' recommendations.
- .8 Coordinate with Structure/Architecture design to ensure providing the needed structural support for the selected equipment as per A/V equipment manufacturers' recommendations.
- .9 Coordinate civil works in connection with the audiovisual system such as cutting, patching and painting of walls.
- .3 Coordinate the mounting location of AV devices with other building trades. Coordination shall include the mounting location of the device, mounting hardware, back boxes, and other nearby equipment.
 - .1 Where input panels are flush mounted in work surfaces, coordinate the location and mounting with other AV devices, voice/data outlets, electrical receptacles, and furniture or millwork. Refer to device specifications for additional mounting requirements.
 - .2 Where display devices are mounted, coordinate the location of AV back boxes, voice/data outlets, and electrical receptacles with the exact mounting hardware to be installed for equipment support to provide clear access to cables and connectors.
 - .3 Where touch screens are surface mounted, coordinate location of cable routing with other AV devices, voice/data outlets, electrical receptacles, and furniture or millwork. Provide grommets as necessary for cable routing. Refer to device specifications for additional mounting requirements.

1.7 Confidentiality

- ~~.1 The Contractor shall respect and protect the privacy and confidentiality of Employer, his employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the Employer policies.~~
- ~~.2 Contractor shall sign a non-disclosure agreement and abide by the requirements to keep confidential all information concerning bid documents and this Project.~~

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1.8 System Description

- .1 It is the intent of these specifications to provide a complete working audiovisual system ready for the Employer's use. System acceptance shall be judged on the successful adherence to the installation instructions of this Specification.
- .2 Any item not specifically shown on the Drawings or called for in the Specifications, but normally required to conform to the intent, shall form part of the works.
- .3 Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item shall not be permitted, unless specifically noted otherwise.
- .4 These specifications are equipment and performance specifications and are considered to be an encompassing package with the Drawings. Actual installation shall be as engineered by the Contractor with prior approval by the Engineer and Employer.
- .5 Provide audiovisual devices and equipment with performance levels and capacities as noted herein.
- .6 General Conditions
 - .1 The Contractor shall be familiar with, and shall have expertise in the works of this nature and scope. The Contractor shall provide all works as may be required to produce a complete job of that which may not be fully defined in the Contract Documents.
 - .2 The Contractor shall comply with all of the regulations, including safety regulations of national, city, local and other government agencies having jurisdiction concerning the works. The Contractor shall give all notices and comply with all laws, ordinances, codes, rules, and regulations bearing on the conduct of the works. If the Contractor performs any work, which is contrary to such laws, ordinances, codes, rules and regulations, he shall make all changes for compliance and bear all associated costs.
 - .3 The Contractor shall provide all protection necessary to safeguard the works from damage by his operations and the operations of others.
 - .4 The project documentation is, in general, diagrammatic and/or developed to communicate design intent. The Contractor shall coordinate the installation of all devices and/or equipment with the Employer / Engineer prior to installation based on the existing field conditions.
 - .5 The Contractor warrants that both he and his subcontractors are licensed as required by the Authorities Having Jurisdiction and as required by local regulations.
 - .6 It shall be understood that the Specifications and Drawings are complementary. Where there are conflicts within the documents, the overall design intent shall govern. Any discrepancies in these documents shall be brought to the Engineer's attention.

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- .7 The Drawings utilize symbols and schematic diagrams that have no dimensional significance. The works shall be installed to fulfill the diagrammatic intent expressed on the Drawings and approved shop drawings of all trades.
- .8 Certain details appear on the Drawings that are specified with regard to the dimensioning and positioning of the works. These are intended for general information purposes. They do not preclude field coordination for individual items of the indicated works.
- .9 Ratings of devices, materials, and equipment specified without reference to specific performance criteria shall be understood to be nominal or nameplate ratings established by means of industry standard procedures.
- .10 The Contractor shall identify the Structured Cabling system requirements in terms of cable types, quantities, lengths and final locations to be terminated. It shall be the responsibility of the Contractor to ensure that the information is complete and accurate. Any errors or omissions in the ordering information shall be the responsibility of the Contractor.
- .11 The contractor shall coordinate with all involved disciplines (ID, EL, etc.) to ensure that all visible AV components (faceplates, etc.) follow the finish, mounting etc. as desired and approved by the ID, EL, etc.

1.9 Performance Standards

- .1 Unless required by the specifications of a particular equipment or system, the following performance standards shall be met by each system:
 - .2 Performance Test Signal Paths
 - .1 The signal paths for the above Performance Standards shall be as follows:
 - .1 Audio:
 - .1 From all source inputs (for microphones, audio tape units, video tape units, etc.) through all mixers, switchers, etc., to all signal destinations.
 - .2 Video:
 - .1 From all sources of the above signal paths. This shall not exempt the Contractor from the responsibility of checking all paths and outlets for appropriate compliance with the Performance Standards listed herein.
 - .3 Optical Performance Standards
 - .1 System design shall be based "ANSI/Infocomm 3M: 2011, Projected Image System Contrast Ratio", with the following performance criteria:
 - .1 Viewing Requirement Categories Rationale: Basic Decision Making.
 - .2 Contrast ratio between the ambient light and the projected image (assuming perfect black level for the projector): 15:1.

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- .3 Uniformity: Shall confirm with “ANSI/Infocomm 3M: 2011, Projected Image System Contrast Ratio” standard “Partially Conforms” verification criteria; “The contrast ratio of one but no more than four measurement (viewing) locations falls below the required contrast ratio for the identified viewing category by no more than 10%.”
- .2 The light meter used for the above measurements shall be a properly calibrated foot-candle (or lux) meter and shall be cosine-corrected.
- .3 Projectors, lenses, and mirrors shall be solidly mounted and braced and structurally isolated, so that there will be no observable movement in the image induced by building structure movement, motor vibration or other mechanical operations.
- .4 Control System User Interface
 - .1 The control system GUI shall be designed for this project exclusively and shall be based on the ID concept for expected application and in coordination with the client/operators.. While there are a great number of design approaches to designing the user interface, the following guidelines shall be adhered to:
 - .1 All panels shall have the time and date as icons, in the same position on every page.
 - .2 All panels shall have a title, indicating the piece of equipment and/or functionality being controlled.
 - .3 User interface design, shall, to the greatest extent possible maintain continuity throughout the Project, taking into account the variations in system functionality from room type to room type.
 - .4 Shall Comply with InfoComm Dashboard for Controls design guide
 - .2 Final programming shall include capability to remotely control all functions of the Audiovisual system. Individual device controls shall provide full manufacturer’s functionality.
 - .3 Devices similar in nature, shall be programmed to operate with a common format.
 - .4 Functions used during a general presentation shall be accessible with a minimal amount of button presses/page flips.
 - .5 Where feasible, multi-level access to controls should be implemented.
 - .6 During performance testing, all equipment shall be operated under standard conditions as recommended by the manufacturer.
- .5 System Availability: At any given time, the overall AV shall be considered unavailable if the system is not available, not fully or accurately functional, or does not meet performance criteria for the given connection. All AV components shall execute, without degradation, at the scheduled periods and response times for the systems to be considered available. The systems shall operate as specified twenty-four (24) hours per day, seven 7 days per week. Availability of the overall AV shall be at least 99.999% (5 minutes maximum downtime per year).

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.6 Audio System/Electro-Acoustics:

- .1 System design shall be based on the following performance criteria for general areas
 - .1 Average sound pressure level: 65
 - .2 System headroom of 20 dB over the average power (Amplifiers shall have a dynamic headroom over the required power to accommodate the requirement).
 - .3 Intelligibility index: STI: better than 0.60 or better.
 - .4 Sound diffusion level: 15 dB (A) above ambient noise level.
 - .5 Total harmonic distortion: maximum 0.05% at specified output level.
 - .6 Frequency response: +/- 3 dB over 70 Hz to 20 kHz.
 - .7 Performance coverage envelope: 3 dB (0.25, 0.5, 1, 2, 4 and 8 kHz).
- .2 System design shall be based on the following performance criteria for Conference theater
 - .1 Average sound pressure level: 70
 - .2 System headroom of 20 dB over the average power (Amplifiers shall have a dynamic headroom over the required power to accommodate the requirement).
 - .3 Intelligibility index: STI: better than 0.75 or better.
 - .4 Sound diffusion level: 15 dB (A) above ambient noise level.
 - .5 Total harmonic distortion: maximum 0.05% at specified output level.
 - .6 Frequency response: +/- 3 dB over 40 Hz to 20 kHz.
 - .7 Performance coverage envelope: 3 dB (0.125, 0.25, 0.5, 1, 2, 4, 8 and 16 kHz).

1.10 Submittals

- .1 The Contractor shall not perform any part of the work requiring submittal and review of shop drawings, product data or samples until Engineer / Employer has approved the respective submittal. Such work shall be in accordance with approved submittals:
 - .1 Product data: For each type of product.
 - .2 Shop Drawings.
 - .3 Wiring diagrams to show typical wiring schematics.
 - .4 System Operation: Include:
 - .1 System Architecture and performance requirements.
 - .2 Inter-connectivity patching of all network devices
 - .3 Human Machine Interface (HMI) design for all categories of users.

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- .4 Software Architecture and justification (e.g.: off-the-shelf and specific software, etc.).
- .2 Submittals shall comply with Division 01 requirements including but not limited to Sections "Submittal Procedures", "Closeout Procedures" and "Record (As-Built) Documents".
- .3 Samples for initial selection:
 - .1 Manufacturer's color photographs or color chips showing the full range of colors available for speakers and microphones.
 - .2 Representative operating models of speakers and microphones.
- .4 Prefabrication Submittals
 - .1 Submit pre-fabrication submittals in accordance with the Project construction schedule.
 - .2 Pre-fabrication submittals shall consist of product data, shop drawings, samples, and a detailed completion schedule.
 - .3 No portion of the works shall commence nor shall any equipment be procured until the Engineer has approved the pre-fabrication submittals in writing.
- .5 Product Certificates: signed by manufacturers of equipment and /or software certifying that furnished products comply with contract requirements.
- .6 Seismic Qualification Certificates: For control consoles, equipment cabinets and racks, accessories, and components, from manufacturer.
 - .1 Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - .2 Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - .3 Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- .7 Manufacturer's Endorsement
 - .1 Contractor shall submit Manufacturer's technical validation and endorsement of the design documentation and implementation.
- .8 Technical Study.
 - .1 A thorough study of the different design possibilities shall be carried out by the Contractor to achieve the Contract objectives/project's Performance Standards. The study shall be checked and approved by the Employer/Engineer before any attempt by the Contractor to order and process the system.
 - .1 The technical study shall take into consideration, depending on the system/area being examined:
 - .1 Types of zoning.

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- .2 Ambient noise, light, etc.
- .3 Ways of implementing them through the dedicated technical rooms.
- .2 The objectives of the study would be to derive, depending on the system/area being examined:
 - .1 The adopted types of loudspeakers.
 - .2 The adopted types of amplifier
 - .3 The number, position and types of loudspeakers
 - .4 The number, position and types of microphone sensors in each area
 - .5 The number, position and types of projectors
 - .6 The number, position and types of calibration cameras
 - .7 Number and position of laser sensor
- .3 The following possibilities shall be taken into account:
 - .1 Principal network out of order.
 - .2 Principal power supply out of order.
- .4 The technical study shall take into consideration the following aspects:
 - .1 Redundant servers shall be operating in hot standby and any update shall be automatically done on both servers.
 - .2 The redundant server for the video mapping system, shall be capable of hosting all the available content from all servers, and shall be operating in hot standby.
 - .3 The software license shall not be limited and shall cover any number of users.
 - .4 The control workstations in the AV equipment room shall be PC-based with GUI's featuring capabilities for system configuring, annunciation, diagnosis etc. However, access shall be allowed from other system workstations/touch panels after identification through appropriate password.
 - .5 The Contractor shall provide the revised list of AV system equipment and where they would be located.
 - .6 There shall be server-based streaming music sources.
 - .7 The Fire Alarm System shall provide hard-wired contacts corresponding to alarm, trouble etc.
 - .8 System shall provide alarm log and event log separately. Logs shall not be auto-purged without a manual confirmation (say after 90 days) and only after confirmation with the Employer.
 - .9 The system design and specification shall meet or exceed the specified Project performance criteria.

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- .10 The speakers provided in all areas may result in echo. The Contractor shall investigate delay possibilities to insure proper sound intelligibility.
- .5 As part of the study a mock-up test shall be made where deemed necessary.
- .6 Based on the studies carried out as specified above, the contractor shall submit for the engineering approval the proposed optimal design to achieve the desired performance. Any changes in quantities and types of the devices shall be submitted for the engineer/employer's approval prior to installation, and shall be installed at no additional cost to the employer.
- .9 Product data required as part of the pre-fabrication submittal shall include the following:
 - .1 Equipment schedules listing all System components, manufacturer, model number and the quantity of each.
 - .2 General functional description for each System.
 - .3 Manufacturer's product data sheets for all materials and equipment proposed for use on the Project sorted by room and indexed. Include any warranty information.
 - .1 Mark each product data sheet to show applicable choices and options (sheets containing more than one device or component model number shall be clearly marked to delineate items included in the works).
 - .2 Manufacturer's Data: For each manufactured device, submit manufacturers' specifications and print photograph of the proposed device. Include engineering description, principle of operation, application, and proposed model, style or size clearly indicated.
 - .3 Equipment Datasheets to include as a minimum the following:
 - .1 Product performance and features,
 - .2 Electrical and Environmental requirements (power supply, temperature, humidity, etc.),
 - .3 Software and hardware releases roadmap for the next two years,
 - .4 Troubleshooting guide,
 - .5 Standard tests passed and results,
 - .6 Product certificates,
 - .7 Product compatibility matrix with other manufacturers/vendors.
 - .8 Specify type of testing: in operation or in laboratory.
 - .9 MTBF.
 - .4 Signed Warranty.
 - .1 Comprehensive cost structure according to committed GTI, GTR and MTBF.
 - .2 Maintenance stock dimensioning.

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- .3 Distinguish maintenance during and after Warranty period.
- .4 Teams' organizations (distinguish local and remote teams, give associated manpower).
- .5 Hardware repairs and software patch support procedures.
- .5 Testing Plan:
 - .1 The Contractor shall provide Test Plan elaborating the testing methodologies and schedule to be applied throughout various stages of the work. This shall also include the plan for integrated tests for interface with other systems. The Contractor shall submit the Test Plan for approval by the Employer.
- .6 A complete list of cable and wiring types, sizes, manufacturer, and model number.
- .7 A complete list of finishes and sample graphics, including custom art work and custom graphics (if applicable).
- .8 List of spare parts inventory to provide manufacturer recommended service and maintenance of the works.
- .9 Environmental Requirements. Technical submittal shall confirm the environmental specifications for rooms housing the System. These environmental specifications shall identify the requirements for system configurations for:
 - .1 Floor loading for racks and cabinets.
 - .2 Minimum floor space and ceiling heights.
 - .3 Minimum size of doors for equipment passage.
 - .4 Power requirements: The Contractor shall indicate the specific voltage, amperage, phases, and quantities of circuits required.
 - .5 Air conditioning, heating, and humidity requirements. The Contractor shall identify the ambient temperature and relative humidity operating ranges required to prevent equipment damage.
 - .6 Air conditioning requirements, expressed in BTU per hour, based on adequate dissipation of generated heat to maintain required room and equipment standards.
 - .7 Proposed floor plan based on system configuration.
- .10 Point-by-point compliance statement to the specification, with necessary supporting documents.
- .10 Calculations:
 - .1 Calculations: For amplifiers ratings, speakers selection, distribution, cable sizing and voltage drop.
 - .2 Acoustic simulation for all areas of coverage signed and stamped by manufacturer endorsing the calculations.

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- .3 Calculations shall meet or exceed design parameters specified in this Specification.
- .4 Electro-acoustic simulation for all areas of coverage signed and stamped by manufacturer endorsing the calculations. The Electro-acoustic simulation shall be implemented using the most advanced available acoustic software (statistical calculation shall not be acceptable) to reflect the following data:
 - .1 Articulation loss of consonant (Alcons%).
 - .2 Sound transmission index (STI).
 - .3 Direct sound pressure level.
 - .4 Total sound pressure level.
 - .5 Room data: reverberation time, proposed location of speakers, interior finishes.
- .5 Calculations shall be as per the approved material submittal and relevant coordinated information received from all involved disciplines. Based on the selection the contractor shall ensure meeting or exceeding the design parameters specified in this Specification.
- .6 Design shown on the drawings shall be checked and verified for compliance with the Project Specifications and with selected manufacturer's material Specifications before any implementation.
- .7 Projection mapping light level simulation shall be implemented using the most advanced available software (statistical calculation shall not be acceptable) to reflect the following data:
 - .1 Lux level.
 - .2 Uniformity of light.
 - .3 Overlapping value.
 - .4 Ambient light of the space.
 - .5 Architectural surface gain (wall, floor, table, screen, etc.).
- .8 Simulation at any point shall take into consideration all the reflections from all the faces.
- .9 Video mapping content shall be provided using the same software used by the approved projection mapping media server to reflect the following:
 - .1 A complete simulation of the space showing how the content will be shown on different surfaces.
 - .2 Refer to section 2.12 "CREATIVE CONTENT" for details

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.11 Coordination Drawings:

- .1 Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.

.12 Shop Drawings

- .1 Shop Drawings shall include the following:
 - .1 Detailed plan views and elevations of technical rooms showing raceways, sleeves, cable trays, equipment racks, equipment cabinets, termination blocks, power socket outlets and grounding bus bars.
 - .2 Drawings to show evidence of coordination with other trades.
 - .3 Wiring layouts denoting cable type, signal type, termination type, cable number designation, start point and end point.
 - .4 Cable termination schedules showing cable transmission and device location. Provide schedules in printed and electronic format.
 - .5 Floor plan drawings indicating device locations with device legends.
 - .6 System riser diagram with all devices, wire runs, and wire designations.
 - .7 Schematic block diagrams for each system showing all equipment, interconnects, signal flow, etc.
 - .8 Wiring diagrams for each subsystem defining the interconnection of all inputs and outputs for all equipment
 - .9 Fabrication shop drawings for all custom equipment - if applicable.
 - .10 Plans and elevations of the Audiovisual equipment racks and/or custom furniture, including consoles, desks, and lecterns, quantifying all equipment to be mounted therein.
 - .11 The Contractor shall submit samples of any equipment components upon request of the Employer / Engineer. Samples submitted shall be the latest version of equipment.
 - .12 It shall be the responsibility of the Contractor to confirm that all supplied materials and products have been coordinated with other trades. Approval of shop drawings containing errors, does not relieve the Contractor from making corrections at their expense.

.13 Qualifications

- .1 The Contractor shall provide the appropriate documentation to comply with the requirements described in Article "QUALITY ASSURANCE", included with, and at the time of, bid submission.

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.14 Closeout Submittals (Record Documents):

- .1 Record Documentation shall include all information required in the Pre-fabrication Submittals but revised to reflect "As-Installed" or "As-Built" conditions.
- .2 The Contractor shall submit Record Documents (in a format compatible with Microsoft software unless otherwise indicated) for products and systems including but not limited to:
 - .1 Schematic network diagrams.
 - .2 Parts lists.
 - .3 Software and Firmware Operational Documentation:
 - .1 Software operating and upgrade manuals.
 - .2 Program Software Backup: On magnetic media or compact disk, complete with data files.
 - .3 Printout of software application and graphic screens.
 - .4 All programming and source code shall be considered as a work for hire and shall be the property of the Employer upon completion of the project.
 - .4 Manufacturers' information on all system components.
 - .5 Recommended list of spare parts and components to be stocked at Project site.
 - .6 Test Reports.
 - .7 Training Manuals.
 - .8 Warranties.
 - .9 Record (As-Built) Drawings.
- .3 Record (As-Built) drawings: Dimensions and scale of the drawing sheets shall match those used for the Contract documents, and shall include the components and cable numbers labeled in accordance with Division 27 Section "Identification for Communications Systems".
 - .1 Utilize normal recognized drafting procedures that comply with Division 01 requirements.
 - .2 Graphical symbols and component identification on detail drawings should use commonly understood, unique and unambiguous symbols (an example of such a system is IEC 60617) - to the approval of the Engineer.
 - .3 The As-Built drawings shall incorporate all changes made to the project identified in, but not limited to, addenda, change notices, site instructions or deviations resulting from site conditions.

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- .4 Contractor shall provide dimensioned plan and elevation views of networking components, showing:
 - .1 Floor plan drawings indicating device locations, with device legends indicating manufacturers and model numbers for each device.
 - .2 Floor plan drawings indicating wire routing: wire routing shall be delineated in straight line runs and be tagged with cable identification and terminal strip numbers to coincide with the installation.
 - .3 Mounting details for all equipment and hardware.
 - .4 Functional block diagrams for each subsystem.
 - .5 Wiring details showing rack elevations, equipment wiring and terminations, and inter-rack wiring.
 - .6 Wiring diagrams for all custom circuitry including interfaces to various control output controlled devices, lighting control interfaces, projection screens, operable window treatments, motorized doors/partitions, etc.
 - .7 Wiring diagrams for each System: wiring diagrams shall be identical to those laminated and located within the door of rack/cabinet.
 - .8 Layout details for each riser location, including audiovisual panels, power supplies, junction boxes, conduit, and any other audiovisual related equipment.
- .15 Operations and Maintenance Manuals
 - .1 The Contractor shall submit an Operations and Maintenance Manual for products, software modules and systems including but not limited to:
 - .1 Operational description of each subsystem.
 - .2 Detailed programming descriptions for each subsystem.
 - .3 Explanation of subsystems interrelationships
 - .4 Electrical schematics for each piece of equipment specified.
 - .5 Power-up and power-down procedures for each subsystem.
 - .6 Description of all diagnostic procedures.
 - .7 A menu tree for each subsystem.
 - .8 Setup procedures for each component of the subsystems.
 - .9 A list of manufacturers, their local representatives, and subcontractors that have performed works on the Project.
 - .10 Installation and service manuals for each piece of equipment.
 - .11 Maintenance schedules for all installed components.

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- .2 Operations and Maintenance Manuals shall be formatted in accordance with Division 01 requirements.
- .3 Operations and Maintenance Manuals shall include a separate section for each software program incorporated into the Project. The software section shall include, at a minimum, the following information:
 - .1 Definitions of all software related terms and functions
 - .2 Description of required sequences
 - .3 Directory of all disk files
 - .4 Description of all communications protocols, including data formats, command characters, and a sample of each type of data transfer
 - .5 Instructions for manufacturer supplied report generation
 - .6 Instructions for custom report generation
 - .7 Database format and data entry requirements.

1.11 Quality Assurance

- .1 Project Management
 - .1 The Contractor shall assign a Project Manager to oversee and coordinate all activities on the Project.
 - .2 Project Manager's Duties and Responsibilities:
 - .1 The Contractor's designated Project Manager will be recognized as the single point of contact. The Project manager shall oversee all works performed to ensure compliance with the Specifications to ensure a quality installation and on time within project schedule.
 - .2 The Project Manager shall be capable of making all managerial decisions on behalf of the Contractor on a day-to-day basis, and shall retain the authority of accepting notices of deduction, inspection reports, payment schedules and any other project related correspondence on behalf of the Contractor.
 - .3 The Project Manager shall schedule and attend project management meetings, during which time all System related issues are discussed, scheduled, confirmed, and/or resolved.
 - .4 Prior to the initiation of the works, the Project Manager shall submit a schedule reflecting key milestones of the works, including but not limited to the following:
 - .1 Bid award
 - .2 Kick-off meeting
 - .3 Master Plan submittal
 - .4 Prefabrication submittal

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- .5 Ordering, delivery, and installation of head-end system equipment
 - .6 Field equipment delivery
 - .7 Project management schedule
 - .8 Payment schedule
 - .9 Installation completion date
 - .10 System training
 - .11 Delivery of Record (As-Built) documentation
 - .12 Delivery of Operations & Maintenance Manuals
 - .13 Final System test
 - .14 Acceptance of System
 - .5 The Project Manager shall update the work schedule on a weekly basis to reflect the status of each key milestone as the works progress.
 - .6 As the SYSTEM installation progresses, the Project Manager shall be capable of discussing any/or all of the above mentioned items at the request of the Employer / Engineer, and shall address each item, as it relates to the current status of the works.
- .2 Contractor's Qualifications
- .1 Works specified herein shall be the responsibility of the Audiovisual Systems Contractor with a minimum documented experience of five years' prior to commencing the corresponding work for the Project in the fabrication, assembly, and installation of Systems of similar complexity as specified herein. The documentation shall include the names, locations, and points of contact for at least three installations of the type and complexity specified herein.
 - .2 Installer Training Process: Contractor's labor force shall have certified installers who have attended training programs of the proposed system preparing them to perform the work.
 - .3 In order to maintain certain manufacturer's warranties, system equipment must be installed, aligned and serviced by those installers recognized and authorized by said manufacturers to be capable of performing such duties. If a certain installer is not so authorized by a particular manufacturer, it is solely their responsibility to make such arrangements to come into such compliance and they shall bear all costs and consequences thereof.
 - .4 Registered and Certified supervisors: Contractor shall have all supervisory personnel certified for the type of work they are overseeing (with regard to installation and design) by AVIXA "former Infocomm International".
 - .5 Contractor's assigned Project Manager shall oversee and coordinate all activities on the Project as described under Paragraph "Project Management" above.

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- .6 Quality assurance for audiovisual systems shall include a multi-step program consisting of pre-qualification procedure for manufacturers and installation specialists; system engineering; products selection; installation; operating instruction and training; and the submission of maintenance and operating manuals.
 - .7 The Contractor shall have local in-house engineering and project management capabilities consistent with the requirements of the works.
 - .8 By submitting a bid, the Contractor thereby certifies that he is qualified in all areas pertaining to, directly or indirectly, the works. In the event the Contractor becomes unable to complete the works in accordance with the Contract Documents, or the satisfaction of the Employer, it shall be the responsibility of the Contractor to retain the services of applicable manufacturers' representatives to complete the works in accordance with the Project construction schedule with no additional cost to the Employer.
 - .9 The Contractor shall maintain a fully staffed office including a service center capable of providing maintenance and service to the Project. The Contractor shall staff the service center with factory-trained technicians and adequately equip the office to provide emergency service to the Project.
 - .10 The Contractor shall provide factory-certified technicians to install, commission, and maintain the works.
 - .11 The Contractor shall ensure compliance with, and have a thorough understanding of, all local codes and contract conditions pertaining to this Project.
 - .12 The Contractor shall maintain an inventory of spare parts and other items critical to System operation and as necessary to meet the emergency service requirements of this Project within the local service center during the Warranty period.
- .3 Materials and Equipment
- .1 Materials and equipment shall conform to the latest issue of referenced industry standards, publications, or regulations referenced in this Section, as applicable.
 - .2 Materials and equipment shall comply with applicable local regulations and code requirements of Authorities Having Jurisdiction. These shall have precedence over other codes and standards indicated, unless otherwise approved by the Employer / Engineer, in writing.
 - .3 Source Limitation: For each category of technology used for the SYSTEM infrastructure, obtain system components from one manufacturer who shall assume responsibility for the system components and for their compatibility.

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- .4 Materials and equipment shall be new and shall meet or exceed the latest published specification of the manufacturer in all respects.
 - .1 These specifications represent the prevailing technology at the time of design. However, during construction, and because the technology may be rapidly evolving, the Contractor is required to propose an upgrade of the specified systems to the latest technology available, so as to bring the specified items to the prevailing technology at the time of construction.
 - .2 It is the Contractor's responsibility to amend, as deemed necessary, any other systems affected by the upgraded submission so as to allow for the complete and proper functionality of all submitted state-of-the-art systems, equipment and relevant products.
 - .3 All necessary additional works that result from the upgraded materials, systems, equipment and the ancillary works are to be proposed and detailed in the shop drawings.
 - .4 The Contractor's proposals must allow in the shop drawings for physical space, electrical/mechanical support, network connectivity and other incidental items required for the installation of the proposed updated systems and equipment.
 - .5 The Employer / Engineer shall review the proposal and shall decide whether or not such substitutions will be appropriate, and prices shall be adjusted to reflect increase or decrease in cost to Employer. The cost of any change to the converged network system, the infrastructure cabling or physical plant design due to such changes shall be included in the presented cost revision prior to Employer's /Engineer's acceptance.
- .5 Equipment shall generally be supplied in complete factory assembled units ready for installation on site. Dis-assembly necessary for transportation or other purposes shall be arranged to limit site work to simple re- assembly and inter-wiring of control and power cabling.
- .6 Equipment and materials shall Be Underwriters Laboratories, Inc. (U.L.) or Technischer Überwachungs-Verein (TÜV) listed and approved where specifically called for; or where normally subject to such U.L. or TÜV labeling and/or listing services.
- .7 Equipment Country of Origin
 - .1 Equipment Country of Origin (manufacturing country) shall be indicated in the proposal at time of bid submission. Refer to Division 01, Section "Product Requirements".
- .4 Electromagnetic compatibility
 - .1 Ensure all equipment and systems are installed to provide electromagnetic compatibility within the system and with any other systems installed in the same location.

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1.12 Delivery, Storage and Handling

- .1 Comply with Division 01, Section "Product Requirements".

1.13 Project/Site Conditions

- .1 Environmental Conditions: Equipment shall be capable of withstanding the project environmental conditions specified under Division 26 Section "Basic Electrical Materials and Methods" encountered at the installed location without mechanical or electrical damage or degradation of operating capability as applicable to:
 - .1 Interior, Controlled Environments.
- .2 Operational Constraints:
 - .1 All products shall be capable of operating continuously for 24 hours per day, 7 days per week over an ambient temperature range of +10°C to +40°C and a relative humidity of 20% to 90% non-condensing without damage, unless otherwise noted.
- .3 Unless otherwise indicated, 25% spare capacity shall be required at all levels of the SYSTEM.
 - .1 The Contractor shall clearly state limitations of the proposed system in terms of adding additional capacity including limitations for the number of devices per circuit.
- .4 Power Supply
 - .1 Power supply for all products shall be supplied or derived from the voltage system described below, as shown on the Drawings, or as otherwise specified.
 - .2 Nominal characteristics of power supply and distribution system (AC voltage / No. of Phases / Frequency / Earthing system) shall be as per local country standard. For details, refer to Division 26 Section "Basic Electrical Materials and Methods".

1.14 Warranty and Maintenance

- .1 Contractor shall provide a two> years warranty for the works, Systems, and subsystems specified herein, including all materials, software and labor, to be free from defects in design, workmanship, and materials.
- .2 Warranty period shall commence from date of Taking Over of the SYSTEM and shall be revised in accordance with Division 01, Section "Product Requirements" depending on Equipment Country of Origin.
- .3 Further, the Contractor shall warrant that the completed systems, including all components (except those, which are existing or provided by others), are of sufficient size and capacity to fulfill the requirements of the Specifications.
- .4 The warranty shall be valid following the date of SYSTEM Acceptance by the Employer. System Acceptance shall commence when all parts, components, Systems and Sub-systems have been tested, shown to be working in accordance with the Specification, and approved by the Employer.

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- .5 Warranty Service: In the event that defects in the materials, software and/or workmanship are identified during the warranty period, the Contractor shall provide all labor, software patches/updates and materials as may be required for prompt correction of the defect.
- .6 Response time: Contractor's service center shall provide maintenance and service to the Project through factory-trained technicians who can attend to and resolve emergency service within two days after being called, 8 hours per day.
- .7 Experimental Period
 - .1 After the on-site tests are satisfactorily completed in accordance with the technical specifications and approved procedures, and before Taking Over, assume a three-months experimental period during which the SYSTEM performance will be fully demonstrated under actual operation conditions. This demonstration is to confirm, to the satisfaction of the Employer / Engineer that the SYSTEM is free of remarks and is ready for taking-over.
 - .2 Contractor shall supervise and take responsibility for the operation of the system during the experimental period. After the satisfactory completion of this period, the system shall be taken over by the Employer, as per Contract conditions, whereby the warranty period shall commence.
- .8 Software Service Agreement
 - .1 Technical Support: Provide software support for two years, beginning at Project Completion.
 - .2 Upgrade Service: Update software to latest version at Project Completion. Install and program software upgrades that become available within two years from date of Project Completion. Upgrading software shall include operating system and new or revised licenses for use of software.
 - .1 Upgrade Notice: At least 30 days to allow Employer to schedule and access the system and to upgrade computer equipment if necessary.

1.15 Spare Parts and Extra Material

- .1 The manufacturer shall guarantee the flow and availability of the spare parts without a major design change for at least ten years' period from date of System Acceptance by Employer.

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PART 2 - PRODUCTS

2.1 AV Encoder and Decoder

- .1 Encoder and Decoder devices when connected together shall support point to point AV streaming without setup or configuration.
 - .1 HDBaseT Encoder
 - .1 Basis of Design Encoder Device
 - .2 Encoder Functions
 - .1 Supported input formats
 - .1 HDBaseT
 - .1 DBaseT outputs on HDBaseT Certified products
 - .2 AV over IP System
 - .1 Primary Function
 - .1 The System's primary function shall be to facilitate Audio and Video Distribution over a standard 1 Gigabit network. System components Shall include support for Real-Time 4K60/4:4:4, HDR10/HDR10+ and Dolby Vision content transmission.
 - .1 Maximum Common Resolutions Supported:
 - .1 Progressive
 - .1 4096x2160 DCI 4K & 3840x2160 4K UHD
 - .1 24 Hz / 4:4:4 / 36 bit
 - .2 30 Hz / 4:4:4 / 36 bit
 - .3 60 Hz / 4:2:2 / 36 bit
 - .4 60 Hz / 4:4:4 / 24 bit
 - .2 2560x1600 WQXGA
 - .1 60 Hz / 4:4:4 / 36 bit
 - .3 1920x1080 HD 1080p
 - .1 60 Hz / 4:4:4 / 36 bit
 - .2 Interlaced (Input only)
 - .1 1920x1080 HD 1080i
 - .1 30 Hz / 4:4:4 / 36 bit
 - .2 Encoder to Decoder transmission shall support other custom resolutions at pixel clock rates up to 600 MHz.

Integrated Audio-Visual System

.2 Transmission

.1 1 Gigabit transmission of video over Ethernet with support for the following resolutions:

.1 Progressive

.1 4096x2160 DCI 4K & 3840x2160 4K UHD

.1 24 Hz / 4:4:4 / 36 bit

.2 30 Hz / 4:4:4 / 36 bit

.3 60 Hz / 4:2:2 / 36 bit

.4 60 Hz / 4:4:4 / 24 bit

.1 2560x1600 WQXGA

.1 60 Hz / 4:4:4 / 36 bit

.2 1920x1080 HD 1080p

.1 60 Hz / 4:4:4 / 36 bit

.2 Interlaced (Input only)

.1 1920x1080 HD 1080i

.1 30 Hz / 4:4:4 / 36 bit

.3 Scalability

.1 The System shall be capable of supporting an unlimited number of endpoints.

.2 The Maximum bandwidth requirement per encoder or decoder stream shall be 1 Gigabit.

.4 System Integration

.1 The System shall support native integration with a single enterprise grade software management platform to provide complete system monitoring, management, and control.

.1 Management platform shall be available in web-based cloud and on premises deployment options.

.2 Supported Native Integrated sub-systems:

.1 Audio-Video Systems

.2 HVAC Systems

.3 Lighting Systems

.4 Window Shade Systems

Integrated Audio-Visual System

- .3 The enterprise cloud management platform by same manufacturer shall support the following functions:
 - .1 Automatic Device Configuration
 - .1 Cloud Management Platform shall push firmware updates, security patches, device settings, room or device control modules, and user interfaces to supported devices by same manufacturer.
 - .2 Cloud Management Platform shall be capable of managing feature licenses for applicable devices.
 - .3 Cloud software pushes shall not require custom programming.
 - .4 Supported native integrated activities and control functions via control processor or management platform: Automation of room scheduling and device control
 - .5 Occupancy sensor feedback
 - .6 Reporting of asset usage and scheduling
 - .7 Room scheduling
- .5 System Architecture
 - .1 The System shall be composed of the following elements as specified in this specification:
 - .1 Hardware Encoder and Decoder Devices
 - .2 Network Switch
 - .2 AV over IP Optional System Components:
 - .1 Control Processor
 - .2 Switching and Management Appliance
 - .3 The AV over IP System manufacturer shall offer an optional Network Appliance providing the following:
 - .1 Management and single point of control of end points
 - .2 Easy to use Graphic user interface
 - .3 Creation and management of virtual routing matrices including descriptive endpoint naming
 - .4 Diagnostic tool interface and firmware updater
 - .5 Direct endpoint routing

Integrated Audio-Visual System

- .4 The Network Appliance graphical user interface and built-in dashboard functions shall not require custom or project specific programming or API development.
- .6 Device integration and management
 - .1 Network appliance by same manufacturer shall support the following:
 - .1 Virtual matrix switcher supporting connected encoders and decoders
 - .2 Inter domain routing of encoders and decoders
 - .3 Multiple control system support
 - .4 Central updates for encoder and decoder user names and passwords
 - .7 System Control
 - .1 The System shall support the following control capabilities when integrated with a control processor by same manufacturer:
 - .1 Full Native control of encoder and decoder embedded functionality via keypad, touch screen, or management platform by same manufacturer or iOS, Android, Windows or Mac devices running custom control Apps.
 - .2 Control of 3rd party equipment via Encoder and Decoder built-in control ports
 - .1 IR control
 - .2 RS-232 serial control
 - .3 CEC
 - .2 Encoders and Decoders shall support control by a REST interface.
 - .1 An Application Programming interface shall be made available to authorized programmers and or integrators.
 - .8 Adaptive Bit Rate
 - .1 Automatic bit rate adjustment
 - .1 Encoder shall support automatic bit rate adjustment. The active bit rate function shall set the bit rate required for the input resolution of the stream.
- .3 Decoder Functions
 - .1 Background Image Display
 - .1 Device shall support display of a static image from a designated file location.
 - .1 Images may be stored locally or on a networked server.

Integrated Audio-Visual System

- .2 Still Image Detection
 - .1 Decoder shall detect a still image streamed from encoder and allow source switching or display of a selected background image.
- .4 Encoder Functions
 - .1 Encoder devices shall support test pattern generation as source signal.
 - .1 Test patterns shall be generated within the encoder based on user configuration. Transmission of fixed images as test patterns shall not be excepted.
- .5 Network Requirements
 - .1 Infrastructure
 - .1 AV over IP system shall operate on CAT5e or better infrastructure.
 - .2 The AV over IP network shall utilize standard 1 Gigabit Ethernet.
 - .2 Constraints
 - .1 The AV over IP System shall not require proprietary network management software or hardware.
 - .2 The AV over IP hardware shall not require proprietary or manufacturer specific Ethernet switches.
 - .3 Audio Video Bridging (AVB) shall not be required for operation of AV over IP system.
 - .3 Minimum network requirements:
 - .1 1 Gigabit port for each connected encoder or decoder endpoint device
- .6 AV Over IP Hardware Requirements
 - .1 Encoder and Decoder Network Requirements
 - .1 Maximum network requirement per encoder or decoder: 1GB network
 - .2 Encoder/Decoder units shall support web based control and management
 - .2 Enterprise-Grade Security
 - .1 Encoder and Decoder shall employ advanced security features and protocols including:
 - .1 802.1x authentication
 - .2 AES encryption
 - .3 Active Directory credential management
 - .4 HTTPS
 - .5 PKI certification
 - .6 SSH

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- .7 CIP
- .3 Communication
 - .1 Ethernet Port
 - .1 Three 8-wire RJ-45 ports
 - .1 One 100BASE-TX/1000-BASE-T ethernet port, POE+ PD port
 - .2 One 100BASE-TX/1000-BASE-T ethernet port
 - .3 One 100BASE-TX Ethernet port
 - .2 One SFP port
 - .4 Audio and Video Functions:
 - .1 Audio-Video Transmission
 - .1 Forward Error Correction
 - .1 Encoder and decoder units shall utilize Forward Error Correction to minimize vulnerability to interruption from environmental noise and other network issues.
 - .2 Decoder Mode
 - .1 Breakaway Audio - Decoder may select and combine separate video and audio signals from two different inputs, including two different encoders.
 - .2 Decoder unit shall support de-embedding of stereo audio signal from HDMI output.
 - .3 HDMI digital video/audio output
 - .1 One (1) 19-pin Type A HDMI female connector
 - .2 Supports: HDCP 2.3, EDID, CEC
 - .3 Encoder Mode
 - .1 Encoder shall include one HDMI input.
 - .2 One (1) HDMI video, audio, and control input:
 - .1 CEC device control: Through a compatible control processor, the Encoder/Decoder unit shall include a gateway for controlling devices through their HDMI connections using the CEC signal embedded in HDMI.
 - .2 Digital Audio Formats: Dolby Digital®, Dolby Digital EX, Dolby Digital Plus, Dolby TrueHD, Dolby Atmos, DTS®, DTS-ES, DTS 96/24, DTS-HD High Res, DTS-HD Master Audio, DTS:X, LPCM up to 8 channels

Integrated Audio-Visual System

- .3 Input Signal Types: HDMI w/HDR10+, Deep Color, and 4K60 4:4:4 support (Dual-Mode DisplayPort and DVI compatible)
- .4 Supports DVI-D with adaptor
- .5 Supports DisplayPort Dual-Mode
- .6 Supports HDMI: HDCP 2.3, EDID, CEC
- .3 Analog stereo audio input:
 - .1 Left and Right channel stereo; analog balanced or unbalanced
 - .2 Encoder shall support embedding of stereo audio into HDMI input.
- .4 Network Audio
 - .1 Encoders and decoders shall support two channel AES67 network audio.
 - .2 Dante audio and surround audio downmix capability
- .5 Network Port Selection
 - .1 Multiple network ports shall be capable of separating audio stream and USB from video and control stream.
- .6 Video Preview Stream
 - .1 Devices shall support a video preview stream for non-HDCP content.
 - .2 Preview shall be viewable on touch screen user interface by same manufacturer.
- .7 Device Architecture
 - .1 Single hardware component design
 - .1 A single hardware device shall support Encoding mode or Decoding mode.
 - .2 Encoder/Decoder devices shall be available in the following form factors:
 - .1 Card unit for card chassis mounting
 - .2 Freestanding unit for surface, shelf, or rack rail mounting.
 - .3 A rack mount chassis shall be available for mounting and powering high density card versions of encoder/decoder units.
 - .1 Unit front panel shall indicate status of unit and installed cards.
 - .2 Unit front panel shall support network setup of installed cards.
 - .3 Unit shall support hot swappable card interchange.
 - .4 Rack chassis shall include a built-in 100-240VAC power supply.

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- .8 Power supply modes:
 - .1 Local or remote DC power source.
 - .2 Remote power supplied PoE+ switch or power injector from same manufacturer.
- .9 Device Control
 - .1 The free standing Encoder and Decoder Unit shall include built-in RS-232 and IR control ports for control of the connected display or device.
- .10 Device Setup
 - .1 Encoder and Decoder units shall be configurable via a web browser or software tool provided by manufacturer.

2.2 Network AV Encoder (Type 1)

- .1 System
 - .1 Primary Function
 - .1 The System's primary function shall be to facilitate Audio and Video Distribution over a standard 1 Gigabit network. System includes support for Real-Time 4K60/4:4:4 and HDR content transmission.
 - .2 Maximum Common Resolutions Supported:
 - .1 Progressive
 - .1 4096x2160 DCI 4K & 3840x2160 4K UHD
 - .1 24 Hz / 4:4:4 / 36 bit
 - .2 30 Hz / 4:4:4 / 36 bit
 - .3 60 Hz / 4:2:2 / 36 bit
 - .4 60 Hz / 4:4:4 / 24 bit
 - .2 2560x1600 WQXGA
 - .1 60 Hz / 4:4:4 / 36 bit
 - .3 1920x1080 HD 1080p
 - .1 60 Hz / 4:4:4 / 36 bit
 - .2 Interlaced (Input only)
 - .1 1920x1080 HD 1080i
 - .1 30 Hz / 4:4:4 / 36 bit
 - .3 Encoder/Decoder unit shall support other custom resolutions at pixel clock rates up to 600 MHz.

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- .2 Transmission
 - .1 1 Gigabit transmission of video over Ethernet with support for the following resolutions:
 - .1 Progressive
 - .1 4096x2160 DCI 4K & 3840x2160 4K UHD
 - .1 24 Hz / 4:4:4 / 36 bit
 - .2 30 Hz / 4:4:4 / 36 bit
 - .3 60 Hz / 4:2:2 / 36 bit
 - .4 60 Hz / 4:4:4 / 24 bit
 - .2 2560x1600 WQXGA
 - .1 60 Hz / 4:4:4 / 36 bit
 - .3 1920x1080 HD 1080p
 - .1 60 Hz / 4:4:4 / 36 bit
 - .2 Interlaced (Input only)
 - .1 1920x1080 HD 1080i
 - .1 30 Hz / 4:4:4 / 36 bit
 - .2 System end-to-end latency shall not exceed 1 frame of latency at 60 fps (including encoding/decoding and scaling operations).
- .3 Scalability
 - .1 The System shall be capable of supporting an unlimited number of endpoints.
 - .2 The Maximum bandwidth requirement per encoder or decoder stream shall be 1 Gigabit.
- .4 System Integration
 - .1 The System shall support native integration with a single enterprise grade software management platform to provide complete system monitoring, management, and control.
 - .1 Management platform shall be available in web-based cloud and on premises deployment options.
 - .2 Supported Native Integrated sub-systems:
 - .1 Audio-Video Systems
 - .2 HVAC Systems
 - .3 Lighting Systems
 - .4 Window Shade Systems

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- .3 The enterprise cloud management platform by same manufacturer shall support the following functions:
 - .1 Automatic Device Configuration
 - .1 Cloud Management Platform shall push firmware updates, security patches, device settings, room or device control modules, and user interfaces to supported devices by same manufacturer.
 - .2 Cloud Management Platform shall be capable of managing feature licenses for applicable devices.
 - .3 Cloud software pushes shall not require custom programming.
 - .2 Supported native integrated activities and control functions via control processor or management platform:
 - .1 Automation of room scheduling and device control
 - .2 Occupancy sensor feedback
 - .3 Reporting of asset usage and scheduling
 - .4 Room scheduling
- .5 System Architecture
 - .1 The System shall be composed of the following elements as specified in this specification:
 - .1 Hardware Encoder and Decoder Devices
 - .2 Network Switch
 - .2 AV over IP Optional System Components:
 - .1 Control Processor
 - .2 Switching and Management Appliance
 - .3 The AV over IP System manufacturer shall offer an optional Network Appliance providing the following:
 - .1 Management and single point of control of end points
 - .2 Easy to use Graphic user interface
 - .3 Creation and management of virtual routing matrices including descriptive endpoint naming
 - .4 Diagnostic tool interface and firmware updater
 - .5 Direct endpoint routing
 - .4 The Network Appliance graphical user interface and built-in dashboard functions shall not require custom or project specific programming or API development.

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.6 System Control

.1 The System shall support the following control capabilities when integrated with a control processor by same manufacturer:

.1 Full Native control of encoder/decoder embedded functionality via keypad, touch screen, or management platform by same manufacturer or iOS, Android, Windows or Mac devices running custom control Apps.

.2 Control of 3rd party equipment via Encoder/Decoder built-in control ports

.1 IR control

.2 RS-232 serial control

.3 IP control

.4 CEC

.7 Network Requirements

.1 Infrastructure

.1 System shall support fiber optic network connection through hardware options.

.2 AV over IP system shall operate on CAT5e or better infrastructure.

.3 The AV over IP network shall utilize standard 1 Gigabit Ethernet.

.2 Constraints

.1 The AV over IP System shall not require proprietary network management software or hardware.

.2 The AV over IP hardware shall not require proprietary or manufacturer specific Ethernet switches.

.3 Audio Video Bridging (AVB) shall not be required for operation of AV over IP system.

.3 Minimum network requirements:

.1 1 Gigabit port for each connected encoder or decoder endpoint device

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- .8 AV Over IP Hardware Requirements
 - .1 Encoder and Decoder Network Requirements
 - .1 Network Connectivity
 - .1 Encoder and Decoder units shall support connection to a fiber optic network by inserting an appropriate SFP transceiver module into the SFP port on the Encoder/Decoder.
 - .1 The Encoder and Decoder manufacturer shall offer a selection of modules to accommodate various multimode and single-mode fiber types.
 - .1 Encoder/Decoder units shall have native support for single-mode and multimode fiber, external adaptors shall not be required.
 - .2 Available SFP types shall include: Multimode fiber: 850nm, Single-Mode fiber: 1310nm, and 1310/1490 uplink and 1790/1310 downlink.
 - .2 The Encoder and Decoder shall include two RJ45 1000Base-T LAN ports. Either port may be used as the primary LAN connection, allowing the other to be used to provide a network connection for an additional device.
 - .1 Secondary LAN port may also be used to daisy-chain multiple Encoder/Decoder units feeding a single-source video wall or individual displays all showing the same video image.
 - .2 Maximum network requirement per encoder or decoder: 1GB network
 - .3 Encoder/Decoder units shall support web based control and management
 - .2 Enterprise-Grade Security
 - .1 Encoder/Decoder shall employ advanced security features and protocols including:
 - .1 802.1x authentication
 - .2 AES encryption
 - .3 Active Directory credential management
 - .4 HTTPS
 - .5 PKI certification
 - .6 SSH
 - .7 CIP

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.3 Communication

.1 Ethernet Port

.1 SFP transceiver module port

.2 At least (2) 8-wire RJ-45 ports

.1 10/100/1000 Mbps, auto-switching, auto negotiating, auto-discovery, full/half duplex, DHCP

.4 Audio and Video Functions:

.1 Audio-Video Transmission

.1 Decoder units shall provide integrated scaling with no additional latency.

.2 System decoder scaling shall support arbitrary input resolutions up to 4096x2160 4:4:4 @ 60fps.

.3 Switching transition between encoders shall not be greater than 2 seconds.

.4 Switching between sources of the same framerate shall transition cleanly, (i.e. no black frame during the transition).

.5 Forward Error Correction

.1 Encoder and decoder units shall utilize Forward Error Correction to minimize vulnerability to interruption from environmental noise and other network issues.

.2 Decoder

.1 Decoder unit shall include HDMI inputs for connection of local HDMI sources.

.1 HDMI inputs and streaming input may be switched via the control processor, web browser interface, input select button on unit or, auto switch mode.

.2 Breakaway Audio - Decoder may select and combine separate video and audio signals from two different inputs, including two different encoders.

.3 Decoder unit shall be capable of receiving multiple streams, one stream for video and embedded audio output through the HDMI connector and one for stereo audio for output through the analog audio output connector.

.4 Decoder unit shall support de-embedding of stereo audio signal from HDMI output.

.5 Text Overlay - The Encoder/Decoder shall be capable of displaying dynamic or fixed text on screen.

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- .6 Video Wall Processing
 - .1 The Decoder shall support video wall functionality.
 - .2 Video walls composed of up to 64 individual displays shall be supported with configurations using multiple Decoder units.
 - .3 Each Decoder shall provide fully-adjustable zoom capability and bezel compensation.
 - .4 One Decoder is required per display, supporting configurations of up to eight wide by up to eight high.
- .7 HDMI digital video/audio output
 - .1 Supports: HDCP 2.2, EDID, CEC
 - .2 One (1) 19-pin Type A HDMI female connector
- .8 Audio DSP
 - .1 The Decoder shall include the ability to decode the incoming multichannel surround sound signal from the network and downmix that signal to stereo. The stereo downmix signal is automatically routed to the onboard analog output.
 - .1 The following formats shall be supported by downmix function:
 - .1 Dolby Digital®, Dolby Digital EX, Dolby Digital Plus, Dolby TrueHD, Dolby Atmos, DTS®, DTS-ES, DTS 96/24, DTS-HD High Res, DTS-HD Master Audio, DTS:X, LPCM up to 8 channels
- .3 Encoder
 - .1 Encoder shall include dual HDMI inputs with integrated switcher.
 - .2 Two (2) HDMI video, audio, and control input:
 - .1 CEC device control: Through a compatible control processor, the Encoder/Decoder unit shall include a gateway for controlling devices through their HDMI connections using the CEC signal embedded in HDMI.
 - .2 Digital Audio Formats: Dolby Digital®, Dolby Digital EX, Dolby Digital Plus, Dolby TrueHD, Dolby Atmos, DTS®, DTS-ES, DTS 96/24, DTS-HD High Res, DTS-HD Master Audio, DTS:X, LPCM up to 8 channels
 - .3 Input Signal Types: HDMI w/HDR10, Deep Color, and 4K60 4:4:4 support (Dual-Mode DisplayPort and DVI compatible)
 - .4 Inputs shall support the following switching modes:
 - .1 Automatic Switching

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- .2 Manual switching via onboard input select button.
- .3 Remotely via web browser
- .4 Switching via control processor from same manufacturer
- .5 Supports DVI-D with adaptor
- .6 Supports DisplayPort Dual-Mode
- .7 Supports HDMI: HDCP 2.2, EDID, CEC
- .3 Analog stereo audio input:
 - .1 Left and Right channel stereo; analog balanced or unbalanced
 - .2 Encoder shall support embedding of stereo audio into HDMI input.
- .4 Audio DSP
 - .1 The Encoder shall include the ability to decode the incoming surround sound signal from an HDMI input, and downmix that signal to stereo. The stereo downmix signal is automatically routed to the onboard analog output.
 - .1 The following formats shall be supported by downmix function:
 - .1 Dolby Digital®, Dolby Digital EX, Dolby Digital Plus, Dolby TrueHD, Dolby Atmos, DTS®, DTS-ES, DTS 96/24, DTS-HD High Res, DTS-HD Master Audio, DTS:X, LPCM up to 8 channels
 - .2 The Encoder unit distributes both stereo and multichannel signals simultaneously over the network, allowing either signal to be selected at any decoder on the network.
- .5 Device Architecture
 - .1 Single hardware component design
 - .1 A single unit Encoder/Decoder shall be configurable to operate as:
 - .1 AV over IP decoder
 - .2 AV over IP encoder
 - .3 Encoder/Decoder mode of unit shall be switchable from control processor by same manufacturer.
 - .2 Encoder and Decoder devices shall be available in the following form factors:
 - .1 Card unit for card chassis mounting

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- .2 Freestanding unit for surface, shelf, or rack rail mounting.
- .3 A rack mount chassis shall be available for mounting and powering high density card versions of encoder/decoder units.
 - .1 Unit front panel shall indicate status of unit and installed cards.
 - .2 Unit front panel shall support network setup of installed cards.
 - .3 Unit shall support hot swappable card interchange.
 - .4 Rack chassis shall include a built-in 100-240VAC power supply.
- .6 USB and KVM Functionality
 - .1 KVM routing shall not add additional latency to AV transmission.
 - .2 USB routing shall not add additional latency to AV transmission.
 - .3 USB and KVM routing shall be independent of AV routing.
 - .4 USB peripheral device switching functionality shall support:
 - .1 Whiteboards, Touch screens, Game controllers, Cameras, Mobile devices, Headsets, Flash drives
 - .5 Encoder/Decoder USB ports shall be capable of linking with networked USB extender hardware by same manufacturer.
 - .6 Encoder/Decoder Units shall include USB ports capable of linking to other Encoders and Decoders in the system.
 - .7 Built-in USB ports:
 - .1 One (1) USB Type B port
 - .2 One (1) USB Type A port
- .7 Power supply modes:
 - .1 Local or remote DC power source.
 - .2 Remote power supplied UPoE switch or power injector from same manufacturer.

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.8 Device Control

.1 The Encoder/Decoder Unit shall include built-in RS-232 and IR control ports for control of the connected display or device.

.9 Device Setup

.1 Encoder and Decoder units shall be configurable via a web browser or software tool provided by manufacturer.

.4 Manufacturer

.1 Extended Warranty

.1 The AV-over-IP System manufacturer shall provide options for extended warranties on system hardware.

.2 Technical Support

.1 The AV over IP System manufacturer shall provide free 24 hour a day, 7 days a week technical support.

.3 Training

.1 The AV over IP System manufacturer shall provide free Professional Networking and Design Training at worldwide locations.

2.3 Network AV Encoder (Type 2)

.1 HDBase T Encoder

.1 Encoder Functions

.1 Supported input formats

.1 HDBaseT

.1 HDBaseT outputs on HDBaseT Certified products

.2 DigitalMedia

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.2 AV over IP System

.1 Primary Function

.1 The System's primary function shall be to facilitate Audio and Video Distribution over a standard 1 Gigabit network. System components Shall include support for Real-Time 4K60/4:4:4, HDR10/HDR10+ and Dolby Vision content transmission.

.1 Maximum Common Resolutions Supported:

.1 Progressive

.1 4096x2160 DCI 4K & 3840x2160 4K UHD

.1 24 Hz / 4:4:4 / 36 bit

.2 30 Hz / 4:4:4 / 36 bit

.3 60 Hz / 4:2:2 / 36 bit

.4 60 Hz / 4:4:4 / 24 bit

.2 2560x1600 WQXGA

.1 60 Hz / 4:4:4 / 36 bit

.3 1920x1080 HD 1080p

.1 60 Hz / 4:4:4 / 36 bit

.2 Interlaced (Input only)

.1 1920x1080 HD 1080i

.1 30 Hz / 4:4:4 / 36 bit

.2 Encoder to Decoder transmission shall support other custom resolutions at pixel clock rates up to 600 MHz.

.2 Transmission

.1 1 Gigabit transmission of video over Ethernet with support for the following resolutions:

.1 Progressive

.1 4096x2160 DCI 4K & 3840x2160 4K UHD

.1 24 Hz / 4:4:4 / 36 bit

.2 30 Hz / 4:4:4 / 36 bit

.3 60 Hz / 4:2:2 / 36 bit

.4 60 Hz / 4:4:4 / 24 bit

.2 2560x1600 WQXGA

.1 60 Hz / 4:4:4 / 36 bit

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- .3 1920x1080 HD 1080p
 - .1 60 Hz / 4:4:4 / 36 bit
- .2 Interlaced (Input only)
 - .1 1920x1080 HD 1080i
 - .1 30 Hz / 4:4:4 / 36 bit
- .3 Scalability
 - .1 The System shall be capable of supporting an unlimited number of endpoints.
 - .2 The Maximum bandwidth requirement per encoder or decoder stream shall be 1 Gigabit.
- .4 System Integration
 - .1 The System shall support native integration with a single enterprise grade software management platform to provide complete system monitoring, management, and control.
 - .1 Management platform shall be available in web-based cloud and on premises deployment options.
 - .2 Supported Native Integrated sub-systems:
 - .1 Audio-Video Systems
 - .2 HVAC Systems
 - .3 Lighting Systems
 - .4 Window Shade Systems
 - .3 The enterprise cloud management platform by same manufacturer shall support the following functions:
 - .2 Automatic Device Configuration
 - .1 Cloud Management Platform shall push firmware updates, security patches, device settings, room or device control modules, and user interfaces to supported devices by same manufacturer.
 - .2 Cloud Management Platform shall be capable of managing feature licenses for applicable devices.
 - .3 Cloud software pushes shall not require custom programming.
 - .3 Primary Function
 - .1 Supported native integrated activities and control functions via control processor or management platform:
 - .1 Automation of room scheduling and device control
 - .2 Occupancy sensor feedback

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- .3 Reporting of asset usage and scheduling
- .4 Room scheduling
- .5 System Architecture
 - .1 The System shall be composed of the following elements as specified in this specification:
 - .1 Hardware Encoder and Decoder Devices
 - .2 Network Switch
 - .2 AV over IP Optional System Components:
 - .1 Control Processor
 - .2 Switching and Management Appliance
 - .1 The AV over IP System manufacturer shall offer an optional Network Appliance providing the following:
 - .1 Management and single point of control of end points
 - .2 Easy to use Graphic user interface
 - .3 Creation and management of virtual routing matrices including descriptive endpoint naming
 - .4 Diagnostic tool interface and firmware updater
 - .5 Direct endpoint routing
 - .2 The Network Appliance graphical user interface and built-in dashboard functions shall not require custom or project specific programming or API development.
- .6 Device integration and management
 - .1 Network appliance by same manufacturer shall support the following:
 - .1 Virtual matrix switcher supporting connected encoders and decoders
 - .2 Inter domain routing of encoders and decoders
 - .3 Multiple control system support
 - .4 Central updates for encoder and decoder user names and passwords
- .7 System Control
 - .1 The System shall support the following control capabilities when integrated with a control processor by same manufacturer:
 - .1 Full Native control of encoder and decoder embedded functionality via keypad, touch screen, or management platform by same manufacturer or iOS, Android, Windows or Mac devices running custom control Apps.

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- .2 Control of 3rd party equipment via Encoder and Decoder built-in control ports
 - .1 IR control
 - .2 RS-232 serial control
 - .3 CEC
- .2 Encoders and Decoders shall support control by a REST interface.
 - .1 An Application Programming interface shall be made available to authorized programmers and or integrators.
- .3 Adaptive Bit Rate
 - .1 Automatic bit rate adjustment
 - .1 Encoder shall support automatic bit rate adjustment. The active bit rate function shall set the bit rate required for the input resolution of the stream.
- .4 Decoder Functions
 - .1 Background Image Display
 - .1 Device shall support display of a static image from a designated file location.
 - .1 Images may be stored locally or on a networked server.
 - .2 Still Image Detection
 - .1 Decoder shall detect a still image streamed from encoder and allow source switching or display of a selected background image.
- .5 Encoder Functions
 - .1 Encoder devices shall support test pattern generation as source signal.
 - .1 Test patterns shall be generated within the encoder based on user configuration. Transmission of fixed images as test patterns shall not be excepted.
- .6 Network Requirements
 - .1 Infrastructure
 - .1 AV over IP system shall operate on CAT5e or better infrastructure.
 - .2 The AV over IP network shall utilize standard 1 Gigabit Ethernet.
 - .2 Constraints
 - .1 The AV over IP System shall not require proprietary network management software or hardware.
 - .2 The AV over IP hardware shall not require proprietary or manufacturer specific Ethernet switches.

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- .3 Audio Video Bridging (AVB) shall not be required for operation of AV over IP system.
- .3 Minimum network requirements:
 - .1 1 Gigabit port for each connected encoder or decoder endpoint device
- .7 AV Over IP Hardware Requirements
 - .1 Encoder and Decoder Network Requirements
 - .1 Maximum network requirement per encoder or decoder: 1GB network
 - .2 Encoder/Decoder units shall support web based control and management
 - .2 Enterprise-Grade Security
 - .1 Encoder and Decoder shall employ advanced security features and protocols including:
 - .1 802.1x authentication
 - .2 AES encryption
 - .3 Active Directory credential management
 - .4 HTTPS
 - .5 PKI certification
 - .6 SSH
 - .7 CIP
 - .3 Communication
 - .1 Ethernet Port
 - .1 Three 8-wire RJ-45 ports
 - .1 One 100BASE-TX/1000-BASE-T ethernet port, POE+ PD port
 - .2 One 100BASE-TX/1000-BASE-T ethernet port
 - .3 One 100BASE-TX Ethernet port
 - .2 One SFP port
 - .4 Audio and Video Functions:
 - .1 Audio-Video Transmission
 - .1 Forward Error Correction
 - .1 Encoder and decoder units shall utilize Forward Error Correction to minimize vulnerability to interruption from environmental noise and other network issues.

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- .2 Decoder Mode
 - .1 Breakaway Audio - Decoder may select and combine separate video and audio signals from two different inputs, including two different encoders.
 - .2 Decoder unit shall support de-embedding of stereo audio signal from HDMI output.
 - .3 HDMI digital video/audio output
 - .1 One (1) 19-pin Type A HDMI female connector
 - .2 Supports: HDCP 2.3, EDID, CEC
- .3 Encoder Mode
 - .1 Encoder shall include one HDMI input.
 - .2 One (1) HDMI video, audio, and control input:
 - .1 CEC device control: Through a compatible control processor, the Encoder/Decoder unit shall include a gateway for controlling devices through their HDMI connections using the CEC signal embedded in HDMI.
 - .2 Digital Audio Formats: Dolby Digital®, Dolby Digital EX, Dolby Digital Plus, Dolby TrueHD, Dolby Atmos, DTS®, DTS-ES, DTS 96/24, DTS-HD High Res, DTS-HD Master Audio, DTS:X, LPCM up to 8 channels
 - .3 Input Signal Types: HDMI w/HDR10+, Deep Color, and 4K60 4:4:4 support (Dual-Mode DisplayPort and DVI compatible)
 - .4 Supports DVI-D with adaptor
 - .5 Supports DisplayPort Dual-Mode
 - .6 Supports HDMI: HDCP 2.3, EDID, CEC
 - .4 Analog stereo audio input:
 - .1 Left and Right channel stereo; analog balanced or unbalanced
 - .2 Encoder shall support embedding of stereo audio into HDMI input.
 - .5 Network Audio
 - .1 Encoders and decoders shall support two channel AES67 network audio.
 - .2 Dante audio and surround audio downmix capability
- .5 Network Port Selection
 - .1 Multiple network ports shall be capable of separating audio stream and USB from video and control stream.

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- .6 Video Preview Stream
 - .1 Devices shall support a video preview stream for non-HDCP content.
 - .2 Preview shall be viewable on touch screen user interface by same manufacturer.
- .7 Device Architecture
 - .1 Single hardware component design
 - .1 A single hardware device shall support Encoding mode or Decoding mode.
 - .2 Encoder/Decoder devices shall be available in the following form factors:
 - .1 Card unit for card chassis mounting
 - .2 Freestanding unit for surface, shelf, or rack rail mounting.
 - .3 A rack mount chassis shall be available for mounting and powering high density card versions of encoder/decoder units.
 - .1 Unit front panel shall indicate status of unit and installed cards.
 - .2 Unit front panel shall support network setup of installed cards.
 - .3 Unit shall support hot swappable card interchange.
 - .4 Rack chassis shall include a built-in 100-240VAC power supply.
- .8 Power supply modes:
 - .1 Local or remote DC power source.
 - .2 Remote power supplied PoE+ switch or power injector from same manufacturer.
- .9 Device Control
 - .1 The free standing Encoder and Decoder Unit shall include built-in RS-232 and IR control ports for control of the connected display or device.
- .10 Device Setup
 - .1 Encoder and Decoder units shall be configurable via a web browser or software tool provided by manufacturer.

Integrated Audio-Visual System

2.4 USB Converter with HDMI and Analogue Audio Input

- .1 The device captures uncompressed 1080p60 video with stereo digital or analog audio. USB capture is accomplished using the USB Video Class (UVC) and USB Audio Class (UAC) standards, which are compatible with the Most common video capture or streaming software applications. Input resolutions larger than Full HD and up to 4KUHD are automatically scaled to 1080p for USB capture.
 - .1 Architecture
 - .1 Physical Architecture:
 - .1 Converter Construction:
 - .1 The Converter shall be housed in a metal case.
 - .2 The Converter shall include integrated mounting flanges that support simple surface mounting or standard rack rail mounting.
 - .3 All connectors shall be located on opposite edges of the device to allow for mounting the unit in shallow compact locations.
 - .2 Converter Connections:
 - .1 One (1) HDMI Type A input:
 - .1 Supports HDMI 2.0
 - .2 Supports DVI 1.0 with separate adaptor
 - .3 Supports Stereo 2-channel LPCM
 - .2 One (1) 3.5mm TRS input:
 - .1 Supports unbalanced analog stereo audio
 - .3 One (1) HDMI Type A Output:
 - .1 Supports HDMI 2.0 digital video with audio
 - .2 Supports HDCP 2.2/1.x
 - .4 One (1) USB 3.0 Type-B for device video with audio output
 - .1 USB 3.0 device support
 - .2 USB 3.0 UVC support
 - .2 Power supply:
 - .1 The Converter shall be powered by the USB 3.0 connection.

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.2 System Functions

.1 Content Support for video conference systems

.1 The Converter shall support HDMI source conversion for presentation audio and video for software video conference units with USB 3.0 ports.

.2 The Converter shall support the following modes of operation via configuration:

.1 Audio input mode (HDMI or analog)

.2 Device mode (content or camera)

.3 The Converter shall support capture of input signals up to 4KUHD@ 60fps 4:4:4 with support for 12-bit HDR.

.1 1080p60 source video shall be captured uncompressed.

.4 USB capture standards supported

.1 UAC USB Audio Class

.2 UVC USB Video Class

.5 LED Indicators

.1 An Active Connection LED Indicator shall illuminate green to indicate that the connected USB device software is actively receiving video from the converter unit via the USB connection.

.2 An HDCP LED Indicator shall illuminate green, blue, or off to indicate the following HDCP states: Source is using HDCP 1.x, Source is using HDCP 2.2, Source is not using HDCP.

.2 System shall not require separate control equipment normal operation.

2.5 Ceiling Speaker

.1 CEILING SPEAKER TYPE 1:

.1 Device Architecture

.1 Enclosure material: Painted steel, plenum rated.

.2 Baffle: ABS UL94V-0 plastic.

.3 Grille:

.1 Perforated metal

.2 Push-on friction fit

.3 White finish

.4 Mounting:

.1 Flush ceiling mount.

.2 Four integral two-step toggle mounting clamps.

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- .3 Maximum ceiling thickness: 1.5 inches (38 mm).
- .4 Cutout diameter: 6.8 inches (173 mm).
- .5 Minimum ceiling cavity depth: 6.2 inches (156 mm) without conduit.
- .5 Environmental Operating Conditions:
 - .1 Temperature: 20° to 120°F (-7° to 49°C)
 - .2 Humidity: 5% to 95% RH (non-condensing)
- .6 Included Accessories:
 - .1 Support bridge for tile ceiling installation.
 - .1 Adjustable for off center installation.
- .7 Optional Accessories:
 - .1 Safety Tether
 - .1 Have a minimum of one (1) safety wire installation point.
- .8 Termination:
 - .1 4-pin 5 mm screw down conductor detachable terminal block with speaker input and parallel pass-through connections.
 - .2 Maximum wire size: 12 AWG.
 - .3 Conduit knockouts:
 - .1 One 0.5-inch knockout.
 - .2 One 0.75-inch knockout.
- .9 Dimensions:
 - .1 Diameter: 8.11 inches (206 mm), not including toggles.
 - .2 Depth: 5.87 inches (149 mm).
- .10 Weight: 4.9 lb (2.3 kg).
- .11 Drivers:
 - .1 4-inch (102 mm) woofer; cone, ported
 - .2 .79-inch (20 mm) dome tweeter
- .2 Functions
 - .1 Speaker unit shall be equipped for Low Impedance 8 Ω or High Impedance 70 V or 100 V operation.
 - .1 Accessible front mounted low impedance, high impedance selector switch.

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- .2 High Impedance Line Transformer:
 - .1 Four level taps at 70 V:
 - .1 3.75 Watts
 - .2 7.5 Watts
 - .3 15 Watts
 - .4 30 Watts
 - .2 Three level taps at 100 V:
 - .1 7.5 Watts
 - .2 15 Watts
 - .3 30 Watts
 - .3 Low Impedance transformer:
 - .1 8 Ω
 - .3 Sensitivity: 89 dB at one meter, with 1 W input.
 - .4 Frequency Response: Within plus or minus 3 dB from 100 to 15,000 Hz.
 - .5 Frequency Range: Within minus 10 dB from 80 to 20,000 Hz.
 - .6 Nominal Coverage: 120 degrees conical.
 - .7 Power Handling: 30 Watts Program at 8 Ω .
- .3 Compliance
 - .1 UL 1480
 - .2 UL 2043
- .2 CEILING SPEAKER TYPE 2:
 - .1 Device Architecture
 - .1 Enclosure material: Painted steel, plenum rated.
 - .2 Baffle: ABS UL94V-0 plastic.
 - .3 Grille:
 - .1 Perforated metal
 - .2 Push-on friction fit
 - .3 White finish
 - .4 Mounting:
 - .1 Flush ceiling mount.
 - .2 Four integral two-step toggle mounting clamps.

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- .3 Maximum ceiling thickness: 1.5 inches (38 mm).
- .4 Cutout diameter: 8.8 inches (224 mm).
- .5 Minimum ceiling cavity depth: 8.9 inches (226 mm) without conduit.
- .5 Environmental Operating Conditions:
 - .1 Temperature: 20° to 120°F (-7° to 49°C)
 - .2 Humidity: 5% to 95% RH (non-condensing)
- .6 Included Accessories:
 - .1 Support bridge for tile ceiling installation.
 - .1 Adjustable for off center installation.
- .7 Optional Accessories:
 - .1 Safety Tether
 - .1 Have a minimum of one (1) safety wire installation point.
- .8 Termination:
 - .1 4-pin 5 mm screw down conductor detachable terminal block with speaker input and parallel pass-through connections.
 - .2 Maximum wire size: 12 AWG.
 - .3 Conduit knockouts:
 - .1 One 0.5-inch knockout.
 - .2 One 0.75-inch knockout.
- .9 Dimensions:
 - .1 Diameter: 9.95 inches (253 mm), not including toggles.
 - .2 Depth: 8.63 inches (219 mm).
- .10 Weight: 6.9 lb (3.2 kg).
- .11 Drivers:
 - .1 6.5-inch (165 mm) woofer; cone, ported
 - .2 0.79-inch (20 mm) dome tweeter
- .2 Functions
 - .1 Speaker unit shall be equipped for Low Impedance 8 Ω or High Impedance 70 V or 100 V operation.
 - .1 Accessible front mounted low impedance, high impedance selector switch.

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- .2 High Impedance Line Transformer:
 - .1 Four level taps at 70 V:
 - .1 3.75 Watts
 - .2 7.5 Watts
 - .3 15 Watts
 - .4 30 Watts
 - .2 Three level taps at 100 V:
 - .1 7.5 Watts
 - .2 15 Watts
 - .3 30 Watts
 - .3 Low Impedance transformer:
 - .1 8 Ω
- .3 Sensitivity: 91 dB at 1 W, 1 m away.
- .4 Frequency Response: Within plus or minus 3 dB from 95 to 15,000 Hz.
- .5 Frequency Range: Within minus 10 dB from 65 to 20,000 Hz.
- .6 Nominal Coverage: 110 degrees conical.
- .7 Power Handling: 50 W program at 8 Ω
- .3 Compliance
 - .1 UL 1480
 - .2 UL 2043

2.6 Tabletop Touch Screen

- .1 Touch Screen User Interface
 - .1 Device Architecture
 - .1 The Touch Screen UI shall be composed of the following functional elements:
 - .1 Audio intercom
 - .1 2-way intercom and paging with touch screens from same manufacturer
 - .2 2-way intercom via 3rd party SIP system
 - .2 Capacitive graphical touch video display
 - .3 USB port for integrated accessories
 - .4 Built-In proximity sensor
 - .5 Built-in microphone

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- .6 Built-in speakers
- .7 Built-in WiFi
- .8 Built-in bluetooth communications beacon
- .9 Built-in web browsing
- .2 Graphical Display
 - .1 Graphical UI - Touch screen UI display shall support the following viewable elements:
 - .1 Custom control buttons and objects
 - .2 Feedback indication via text, button object change in color, animated object or graphical element.
 - .3 Video streaming support for H.265, H.264, and MJPEG
 - .4 Automatic brightness control
- .3 Scheduling Touch Screens
 - .1 Touch Screen UI shall be available in the following sizes:
 - .1 10 inch TFT active-matrix color LCD touch screen 1920 by 1200 WXGA resolution display.
 - .2 The touch screen shall support native Microsoft Teams operation.
 - .3 The touch screen shall integrate directly with the following scheduling applications:
 - .1 Microsoft Exchange Server software (for users of Outlook® software and Office 365® software), the Google Calendar calendaring app
- .4 Indicator Signs
 - .1 Built-in USB 2.0 Host connection shall be included for optional room availability sign by same manufacturer.
- .5 Touch Functions
 - .1 Touch Screen UI shall support Multi-Touch control interfacing.
 - .2 Touch Screen UI shall support gesture driven controls through custom programming and configuration.
- .6 Device Functions
 - .1 Custom Control UI - control of integrated system components through custom programming or preset configuration of the system control processor by same manufacturer.
 - .2 System Integration - device shall support controls for compatible integrated AV systems, HVAC and Lighting hardware, and scheduling and management systems.

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- .3 Audio Intercom via Ethernet network.
- .4 Custom audio feedback via custom programming.
- .5 Multi-Language support
- .6 Internet Browsing shall be supported via Ethernet network.
- .7 Voice Recognition - device shall support voice commands control functionality through custom programming and configuration of the system control processor.
- .7 Communication
 - .1 Ethernet 100 Mbps, auto switching, auto negotiating, auto discovery, full/half duplex, TCP/IP, UDP/IP, CIP, DHCP, SSL, TLS, SSH, SFTP (SSH File Transfer Protocol), IEEE 802.1X, SNMP, IPv4 or IPv6, Active Directory® service authentication
 - .2 Wi-Fi: IEEE 802.11a/b/g/n/ac
 - .3 Bluetooth
 - .4 USB 2.0: for accessory communication
- .8 Power
 - .1 Power: IEEE 802.3at Type 2 compliant PoE+ Powered Device
- .9 Physical
 - .1 Wired Connection - Device shall utilize a single wired connection for power and data communication.
 - .2 Tabletop Version
 - .1 Touch Screen UI shall be available in the following sizes:
 - .1 10 inch TFT active-matrix color LCD touch screen 1920 by 1200 WXGA resolution display.
 - .2 Wall Mount Version
 - .1 Touch Screen UI shall be available in the following sizes:
 - .1 10 inch TFT active-matrix color LCD touch screen 1920 by 1200 WXGA resolution display.
 - .2 Mounting Options
 - .1 The wall mounted versions shall mount directly to standard electrical boxes using included hardware.
 - .2 Optional mounting hardware shall be available from same manufacturer:
 - .1 Mullion mounting kits
 - .2 Multisurface mounting kits

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- .3 Rackmount mounting kits
- .4 Retrofit mounting brackets
- .5 Back Box and preconstruction mounting kits
- .6 Universal Mounting Bracket

2.7 Wireless Touch Screen

- .1 Provide all equipment in sprinklered areas with accessories to prevent the entry of water into the enclosures in the event that the sprinkler system is activated.
 - .1 Wireless Touch Screen User Interface
 - .1 Device Architecture
 - .1 The Wireless Touch Screen UI shall be composed of the following functional elements:
 - .1 Graphical touch video display
 - .2 Programmable capacitive buttons
 - .2 Graphical Display
 - .1 Graphical UI - Touch screen UI display shall support the following viewable elements:
 - .1 Control buttons and objects
 - .2 Feedback indication via text, button object change in color, animated object or graphical element.
 - .3 H.264 or MJPEG Streaming video via WiFi
 - .3 Touch UI Functions
 - .1 Touch Screen UI shall support Multi-Touch control interfacing.
 - .2 Touch Screen UI shall support gesture driven controls through custom programming and configuration.
 - .4 Functions - The Touch Screen UI shall include:
 - .1 Custom Control UI - control of integrated system components through custom programming or preset configuration of the system control processor by same manufacturer.
 - .2 System Integration - device shall support controls for compatible integrated AV systems, HVAC and Lighting hardware, and scheduling and management systems.
 - .3 Custom audio feedback via custom programming.
 - .4 Multi-Language support
 - .5 Internet Browsing shall be supported via Ethernet network.

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- .6 Voice Recognition - device shall support voice commands control functionality through custom programming and configuration of the system control processor.
- .5 Communication and Power
 - .1 Communication: RF and WiFi
 - .2 Power: Included power pack
- .6 Physical
 - .1 Touch Screen UI shall be dockable in an optional wall dock unit.
- .2 Keypad User Interface
 - .1 Keypad UI
 - .1 Remote Keypad Controls: Field-configurable remote keypad with auto-adjusting backlight illuminating replaceable, engravable programmable buttons in number indicated, with white LED indicators, configured to fit in standard single-gang box.
 - .2 Functions - The Keypad UI shall include:
 - .1 Custom Control UI - control of integrated system components through custom programming or preset configuration of the system control processor by same manufacturer.
 - .2 System Integration - device shall support controls for compatible integrated AV systems, HVAC and Lighting hardware, and scheduling and management systems.
 - .3 Communication and Power
 - .1 Communication: Wired Network Protocol
 - .2 Power: 24 VDC integrated with communication cable
 - .4 Physical
 - .1 Single gang form factor

2.8 Wall Mount Touch Screen

- .1 Touch Screen User Interface
 - .1 Device Architecture
 - .1 The Touch Screen UI shall be composed of the following functional elements:
 - .1 Audio intercom
 - .1 2-way intercom and paging with touch screens from same manufacturer
 - .2 2-way intercom via 3rd party SIP system

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- .2 Capacitive graphical touch video display
- .3 USB port for integrated accessories
- .4 Built-In proximity sensor
- .5 Built-in microphone
- .6 Built-in speakers
- .7 Built-in WiFi
- .8 Built-in bluetooth communications beacon
- .9 Built-in web browsing
- .2 Graphical Display
 - .1 Graphical UI - Touch screen UI display shall support the following viewable elements:
 - .1 Custom control buttons and objects
 - .2 Feedback indication via text, button object change in color, animated object or graphical element.
 - .3 Video streaming support for H.265, H.264, and MJPEG
 - .4 Automatic brightness control
- .3 Scheduling Touch Screens
 - .1 Touch Screen UI shall be available in the following sizes:
 - .1 10 inch TFT active-matrix color LCD touch screen 1920 by 1200 WXGA resolution display.
 - .2 The touch screen shall support native Microsoft Teams operation.
 - .3 The touch screen shall integrate directly with the following scheduling applications:
 - .1 Microsoft Exchange Server software (for users of Outlook® software and Office 365® software), the Google Calendar calendaring app
 - .4 Indicator Signs
 - .1 Built-in USB 2.0 Host connection shall be included for optional room availability sign by same manufacturer.
- .4 Touch Functions
 - .1 Touch Screen UI shall support Multi-Touch control interfacing.
 - .2 Touch Screen UI shall support gesture driven controls through custom programming and configuration.

Integrated Audio-Visual System

- .5 Device Functions
 - .1 Custom Control UI - control of integrated system components through custom programming or preset configuration of the system control processor by same manufacturer.
 - .2 System Integration - device shall support controls for compatible integrated AV systems, HVAC and Lighting hardware, and scheduling and management systems.
 - .3 Audio Intercom via Ethernet network.
 - .4 Custom audio feedback via custom programming.
 - .5 Multi-Language support
 - .6 Internet Browsing shall be supported via Ethernet network.
 - .7 Voice Recognition - device shall support voice commands control functionality through custom programming and configuration of the system control processor.
- .6 Communication
 - .1 Ethernet 100 Mbps, auto switching, auto negotiating, auto discovery, full/half duplex, TCP/IP, UDP/IP, CIP, DHCP, SSL, TLS, SSH, SFTP (SSH File Transfer Protocol), IEEE 802.1X, SNMP, IPv4 or IPv6, Active Directory® service authentication
 - .2 Wi-Fi: IEEE 802.11a/b/g/n/ac
 - .3 Bluetooth
 - .4 USB 2.0: for accessory communication
- .7 Power
 - .1 Power: IEEE 802.3at Type 2 compliant PoE+ Powered Device
- .8 Physical
 - .1 Wired Connection - Device shall utilize a single wired connection for power and data communication.
 - .2 Tabletop Version
 - .1 Touch Screen UI shall be available in the following sizes:
 - .1 10inch TFT active-matrix color LCD touch screen 1920 by 1200 WXGA resolution display.
 - .2 Wall Mount Version
 - .1 Touch Screen UI shall be available in the following sizes:
 - .1 10 inch TFT active-matrix color LCD touch screen 1920 by 1200 WXGA resolution display.

Integrated Audio-Visual System

.2 Mounting Options

- .1 The 7 inch and 10 inch wall mounted versions shall mount directly to standard electrical boxes using included hardware.
- .2 The 5 inch wall mounted version shall mount over a 2 in. H x 3-3/4 in. W cutout using included hardware.
- .3 Optional mounting hardware shall be available from same manufacturer:
 - .1 Mullion mounting kits
 - .2 Multisurface mounting kits
 - .3 Rackmount mounting kits
 - .4 Retrofit mounting brackets
 - .5 Back Box and preconstruction mounting kits
 - .6 Universal Mounting Bracket

2.9 Video Conference Solution

.1 Collaboration Platforms

.1 Microsoft

- .1 The UCS shall natively support Microsoft Teams Rooms.
 - .1 The UCS shall be a certified Microsoft Teams solution.

.2 Zoom

- .1 The UCS shall natively support Zoom Rooms.

.3 BYOD

- .1 UCS shall support collaboration platforms installed on user laptop computers via HDMI and USB connections located on the table transmitter device.

.2 Tabletop Conference Systems

.1 UCS Component orientation

- .1 Tabletop User Interface and Source Laptop Connection Module
- .2 Wall or Equipment Rack mounted UCC assembly unit

.2 Unified Communication System Components:

.1 Hardware Components:

- .1 Tabletop Touch Screen User Interface
 - .1 Tabletop Touch Screen with 10 inch display
 - .2 Native Collaboration Software UI

Integrated Audio-Visual System

- .2 Table Transmitter
 - .1 UCS shall include a connection hub providing local AV and USB connections with a single cable for transmission to the UCC assembly.
 - .2 Transmitter Unit Available Connections:
 - .1 HDMI source input
 - .2 USB B for audio
 - .3 USB C for source video and audio
 - .4 RJ45 single cable transmission to UCC assembly
 - .5 LAN connection for Tabletop User Interface
 - .6 Network connection for UCC assembly
 - .3 Unified Communications Computer (UCC):
 - .1 The UCC shall include pre-installed collaboration software.
 - .2 The UCC shall include connections for the following hardware devices:
 - .1 AV Source Content Single Cable Extension Receiver
 - .2 Dual displays
 - .3 HD Camera
 - .4 USB Camera
 - .5 Cabling and Mounting Hardware
 - .2 Software Components
 - .1 Integrated Zoom Rooms
 - .2 Integrated Microsoft Teams
- .3 External content source device integration
 - .1 The UCS shall support connection of HDMI source devices for use as collaboration content.
- .4 User Laptop BYOD Integration
 - .1 User laptop shall receive camera and microphone content through a single USB connection.
- .5 Video Presentation
 - .1 The UCS table transmitter shall include an HDMI input connection that is extended to the UCC assembly via a single cable HDBT connection. Additional video and USB extending hardware shall not be accepted.

Integrated Audio-Visual System

.6 Touch Screen User Interface

.1 The UCS shall include an integrated touch screen user interface with the following capabilities:

.1 Native Microsoft Teams Rooms Touch Screen User Interface

.2 One-touch Teams meeting joins

.3 Native Zoom Rooms Touch Screen User Interface

.4 One-touch Zoom meeting joins

.7 Network Management

.1 The Tabletop Conference System shall support:

.1 Cloud based management service by same manufacturer

.2 Cloud-based provisioning enabling complete network configuration in advance of hardware installation, with touchless updates following installation.

.3 Manufacturer Service and Support

.1 Manufacturer shall make available an optional Service and Support plan including the following:

.1 Advance Replacements

.2 Extended Remote Support Hours

.3 Five Year Extended Limited Warranty

.4 Reduced Rate On-Site Support

2.10 Wireless Collaboration Receiver

.1 Multimedia Presentation Gateway

.1 General Functionality

.1 Content View

.1 The device shall support dual source view of two separate content devices.

.2 Content view shall support a light theme and a dark theme background.

.2 User Support

.1 Status of connected user shall be viewable on status page.

.2 The device shall support up to ten connected presenter users.

.3 Gateway shall be fully functional as a stand-alone source device when used with a connected display and supported networked mobile device or desktop/laptop.

Integrated Audio-Visual System

- .4 Gateway shall support presentation of content from multiple connection types
 - .1 Wireless through USB-C adaptor
 - .2 Network connected devices
 - .3 Directly connected devices via built-in HD video connection(s).
- .5 Gateway shall support multiple network connected device types as sources for content output
 - .1 Compatible digital signage systems
 - .2 Desktop computers
 - .3 Laptop computers
 - .4 Smartphones
 - .5 Tablet computers
- .6 Gateway shall support integration with scheduling software
 - .1 Google Calendar
 - .2 Microsoft Office 365
 - .3 Microsoft Outlook
 - .4 Scheduling and management software by same manufacturer
- .7 Gateway shall support remote cloud provisioning software integration
 - .1 Cloud provisioning and management software by same manufacturer
- .8 Gateway shall support multiple methods of automatic on and off power control of connected display device
 - .1 CEC
 - .2 IR commands
 - .3 Serial commands
- .9 Gateway shall support display of digital signage content when primary wired or networked source are not active
- .10 Gateway shall display customizable user guidance instructions on connected display
- .11 Presenter Device Support
 - .1 Gateway shall support multiple user device types and Operating Systems:
 - .1 Laptop and desktop computers:
 - .1 Windows XP, Windows Vista, Windows 7, Windows 8, Window 10, Mac OS X (versions 10.5 thru 10.11)

Integrated Audio-Visual System

- .2 Mobile Devices:
 - .1 Apple iOS, Android, Chrome OS
 - .2 Gateway shall support remote provisioning and management
- .2 Automation Functions
 - .1 The presentation gateway shall support direct integration with room occupancy sensors from same manufacturer.
- .3 Control Functions
 - .1 The presentation gateway shall support manual control by networked touch screen by same manufacturer.
 - .2 Optional touch screen shall support source selection, display power control and device audio control.
 - .3 Gateway shall support control of source selection and user control via Windows or Mac Applications.
 - .4 Control up to ten sources or users in a collaboration session
 - .5 Support for collaborative sessions with multiple users or sources and sharing up to 2 sources on the screen
- .4 Architecture
 - .1 Physical Form factor
 - .1 Surface mount via integrated flange
- .5 Communication
 - .1 Dedicated LAN Connection
 - .1 10/100 Mbps, auto-switching, auto-negotiating, full/half duplex, DHCP, SSL, TLS, SSH, SNMP, IPv4, HTTPS web server
- .6 Audio
 - .1 Audio Format: Stereo
- .7 Video
 - .1 Video Frame Rate Supported: up to 30 fps
 - .2 Supported Resolutions
 - .1 640x480@60Hz, 800x600@60Hz, 1024x768@60Hz, 1280x720@50Hz (720p50), 1280x720@60Hz (720p60), 1280x800@60Hz, 1366x768@60Hz, 1440x900@60Hz, 1600x900@60Hz, 1600x1200@60Hz, 1680x1050@60Hz, 1920x1080@50Hz (1080p50), 1920x1080@60Hz (1080p60), 1920x1200@60Hz

Integrated Audio-Visual System

2.11 Virtual Switching Appliance

.1 System

.1 Primary Function

.1 The System's primary function shall be to facilitate Audio and Video Distribution over a standard 1 Gigabit network. System includes support for Real-Time 4K60/4:4:4 and HDR content transmission.

.1 Maximum Common Resolutions Supported:

.1 Progressive

.1 4096x2160 DCI 4K & 3840x2160 4K UHD

.1 24 Hz / 4:4:4 / 36 bit

.2 30 Hz / 4:4:4 / 36 bit

.3 60 Hz / 4:2:2 / 36 bit

.4 60 Hz / 4:4:4 / 24 bit

.2 2560x1600 WQXGA

.1 60 Hz / 4:4:4 / 36 bit

.3 1920x1080 HD 1080p

.1 60 Hz / 4:4:4 / 36 bit

.2 Interlaced (Input only)

.1 1920x1080 HD 1080i

.1 30 Hz / 4:4:4 / 36 bit

.2 Encoder/Decoder unit shall support other custom resolutions at pixel clock rates up to 600 MHz

.2 Transmission

.1 1 Gigabit transmission of video over Ethernet with support for the following resolutions:

.1 Progressive

.1 4096x2160 DCI 4K & 3840x2160 4K UHD

.1 24 Hz / 4:4:4 / 36 bit

.2 30 Hz / 4:4:4 / 36 bit

.3 60 Hz / 4:2:2 / 36 bit

.4 60 Hz / 4:4:4 / 24 bit

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- .2 2560x1600 WQXGA
 - .1 60 Hz / 4:4:4 / 36 bit
- .3 1920x1080 HD 1080p
 - .1 60 Hz / 4:4:4 / 36 bit
- .2 Interlaced (Input only)
 - .1 1920x1080 HD 1080i
 - .1 30 Hz / 4:4:4 / 36 bit
- .2 System end-to-end latency shall not exceed 1 frame of latency at 60 fps (including encoding/decoding and scaling operations).
- .3 Scalability
 - .1 The System shall be capable of supporting an unlimited number of endpoints.
 - .2 The Maximum bandwidth requirement per encoder or decoder stream shall be 1 Gigabit.
- .4 System Integration
 - .1 The System shall support native integration with a single enterprise grade software management platform to provide complete system monitoring, management, and control.
 - .1 Management platform shall be available in web-based cloud and on premises deployment options.
 - .2 Supported Native Integrated sub-systems:
 - .1 Audio-Video Systems
 - .2 HVAC Systems
 - .3 Lighting Systems
 - .4 Window Shade Systems
 - .3 The enterprise cloud management platform by same manufacturer shall support the following functions:
 - .1 Automatic Device Configuration
 - .1 Cloud Management Platform shall push firmware updates, security patches, device settings, room or device control modules, and user interfaces to supported devices by same manufacturer.
 - .2 Cloud Management Platform shall be capable of managing feature licenses for applicable devices.
 - .3 Cloud software pushes shall not require custom programming.

Integrated Audio-Visual System

- .2 Supported native integrated activities and control functions via control processor or management platform:
 - .1 Automation of room scheduling and device control
 - .2 Occupancy sensor feedback
 - .3 Reporting of asset usage and scheduling
 - .4 Room scheduling
- .5 System Architecture
 - .1 The System shall be composed of the following elements as specified in this specification:
 - .1 Hardware Encoder and Decoder Devices
 - .2 Network Switch
 - .2 AV over IP Optional System Components:
 - .1 Control Processor
 - .2 Switching and Management Appliance
 - .1 The AV over IP System manufacturer shall offer an optional Network Appliance providing the following:
 - .1 Management and single point of control of end points
 - .2 Easy to use Graphic user interface
 - .3 Creation and management of virtual routing matrices including descriptive endpoint naming
 - .4 Diagnostic tool interface and firmware updater
 - .5 Direct endpoint routing
 - .2 The Network Appliance graphical user interface and built-in dashboard functions shall not require custom or project specific programming or API development.
- .6 System Control
 - .1 The System shall support the following control capabilities when integrated with a control processor by same manufacturer:
 - .1 Full Native control of encoder/decoder embedded functionality via keypad, touch screen, or management platform by same manufacturer or iOS, Android, Windows or Mac devices running custom control Apps.
 - .2 Control of 3rd party equipment via Encoder/Decoder built-in control ports
 - .1 IR control
 - .2 RS-232 serial control

Integrated Audio-Visual System

- .3 IP control
- .4 CEC
- .2 Network Requirements
 - .1 Infrastructure
 - .1 System shall support fiber optic network connection through hardware options.
 - .2 AV over IP system shall operate on CAT5e or better infrastructure.
 - .3 The AV over IP network shall utilize standard 1 Gigabit Ethernet.
 - .2 Constraints
 - .1 The AV over IP System shall not require proprietary network management software or hardware.
 - .2 The AV over IP hardware shall not require proprietary or manufacturer specific Ethernet switches.
 - .3 Audio Video Bridging (AVB) shall not be required for operation of AV over IP system.
 - .3 Minimum network requirements:
 - .1 1 Gigabit port for each connected encoder or decoder endpoint device
- .3 AV Over IP Hardware Requirements
 - .1 Encoder and Decoder Network Requirements
 - .1 Network Connectivity
 - .1 Encoder and Decoder units shall support connection to a fiber optic network by inserting an appropriate SFP transceiver module into the SFP port on the Encoder/Decoder.
 - .1 The Encoder and Decoder manufacturer shall offer a selection of modules to accommodate various multimode and single-mode fiber types.
 - .1 Encoder/Decoder units shall have native support for single-mode and multimode fiber, external adaptors shall not be required.
 - .2 Available SFP types shall include: Multimode fiber: 850nm, Single-Mode fiber: 1310nm, and 1310/1490 uplink and 1790/1310 downlink.

Integrated Audio-Visual System

- .2 The Encoder and Decoder shall include two RJ45 1000Base-T LAN ports. Either port may be used as the primary LAN connection, allowing the other to be used to provide a network connection for an additional device.
 - .1 Secondary LAN port may also be used to daisy-chain multiple Encoder/Decoder units feeding a single-source video wall or individual displays all showing the same video image.
 - .2 Maximum network requirement per encoder or decoder: 1GB network
 - .3 Encoder/Decoder units shall support web based control and management
- .2 Enterprise-Grade Security
 - .1 Encoder/Decoder shall employ advanced security features and protocols including:
 - .1 802.1x authentication
 - .2 AES encryption
 - .3 Active Directory credential management
 - .4 HTTPS
 - .5 PKI certification
 - .6 SSH
 - .7 CIP
 - .3 Communication
 - .1 Ethernet Port
 - .1 SFP transceiver module port
 - .2 At least (2) 8-wire RJ-45 ports
 - .1 10/100/1000 Mbps, auto-switching, auto negotiating, auto-discovery, full/half duplex, DHCP
- .4 Audio and Video Functions:
 - .1 Audio-Video Transmission
 - .1 Decoder units shall provide integrated scaling with no additional latency.
 - .2 System decoder scaling shall support arbitrary input resolutions up to 4096x2160 4:4:4 @ 60fps.
 - .3 Switching transition between encoders shall not be greater than 2 seconds.
 - .4 Switching between sources of the same framerate shall transition cleanly, (i.e. no black frame during the transition).

Integrated Audio-Visual System

.5 Forward Error Correction

- .1 Encoder and decoder units shall utilize Forward Error Correction to minimize vulnerability to interruption from environmental noise and other network issues.

.2 Decoder

- .1 Decoder unit shall include HDMI inputs for connection of local HDMI sources.
 - .1 HDMI inputs and streaming input may be switched via the control processor, web browser interface, input select button on unit or, auto switch mode.
- .2 Breakaway Audio - Decoder may select and combine separate video and audio signals from two different inputs, including two different encoders.
- .3 Decoder unit shall be capable of receiving multiple streams, one stream for video and embedded audio output through the HDMI connector and one for stereo audio for output through the analog audio output connector.
- .4 Decoder unit shall support de-embedding of stereo audio signal from HDMI output.
- .5 Text Overlay - The Encoder/Decoder shall be capable of displaying dynamic or fixed text on screen.
- .6 Video Wall Processing
 - .1 The Decoder shall support video wall functionality.
 - .2 Video walls composed of up to 64 individual displays shall be supported with configurations using multiple Decoder units.
 - .3 Each Decoder shall provide fully-adjustable zoom capability and bezel compensation.
 - .4 One Decoder is required per display, supporting configurations of up to eight wide by up to eight high.
- .7 HDMI digital video/audio output
 - .1 Supports: HDCP 2.2, EDID, CEC
 - .2 One (1) 19-pin Type A HDMI female connector

Integrated Audio-Visual System

.8 Audio DSP

.1 The Decoder shall include the ability to decode the incoming multichannel surround sound signal from the network and downmix that signal to stereo. The stereo downmix signal is automatically routed to the onboard analog output.

.1 The following formats shall be supported by downmix function:

.1 Dolby Digital®, Dolby Digital EX, Dolby Digital Plus, Dolby TrueHD, Dolby Atmos, DTS®, DTS-ES, DTS 96/24, DTS-HD High Res, DTS-HD Master Audio, DTS:X, LPCM up to 8 channels

.3 Encoder

.1 Encoder shall include dual HDMI inputs with integrated switcher.

.2 Two (2) HDMI video, audio, and control input:

.1 CEC device control: Through a compatible control processor, the Encoder/Decoder unit shall include a gateway for controlling devices through their HDMI connections using the CEC signal embedded in HDMI.

.2 Digital Audio Formats: Dolby Digital®, Dolby Digital EX, Dolby Digital Plus, Dolby TrueHD, Dolby Atmos, DTS®, DTS-ES, DTS 96/24, DTS-HD High Res, DTS-HD Master Audio, DTS:X, LPCM up to 8 channels

.3 Input Signal Types: HDMI w/HDR10, Deep Color, and 4K60 4:4:4 support (Dual-Mode DisplayPort and DVI compatible)

.4 Inputs shall support the following switching modes:

.1 Automatic Switching

.2 Manual switching via onboard input select button.

.3 Remotely via web browser

.4 Switching via control processor from same manufacturer

.5 Supports DVI-D with adaptor

.6 Supports DisplayPort Dual-Mode

.7 Supports HDMI: HDCP 2.2, EDID, CEC

.3 Analog stereo audio input:

.1 Left and Right channel stereo; analog balanced or unbalanced

.2 Encoder shall support embedding of stereo audio into HDMI input.

Integrated Audio-Visual System

- .4 Audio DSP
 - .1 The Encoder shall include the ability to decode the incoming surround sound signal from an HDMI input, and downmix that signal to stereo. The stereo downmix signal is automatically routed to the onboard analog output.
 - .1 The following formats shall be supported by downmix function:
 - .1 Dolby Digital®, Dolby Digital EX, Dolby Digital Plus, Dolby TrueHD, Dolby Atmos, DTS®, DTS-ES, DTS 96/24, DTS-HD High Res, DTS-HD Master Audio, DTS:X, LPCM up to 8 channels
 - .2 The Encoder unit distributes both stereo and multichannel signals simultaneously over the network, allowing either signal to be selected at any decoder on the network.
- .5 Device Architecture
 - .1 Single hardware component design
 - .1 A single unit Encoder/Decoder shall be configurable to operate as:
 - .1 AV over IP decoder
 - .2 AV over IP encoder
 - .3 Encoder/Decoder mode of unit shall be switchable from control processor by same manufacturer.
 - .2 Encoder and Decoder devices shall be available in the following form factors:
 - .1 Card unit for card chassis mounting
 - .2 Freestanding unit for surface, shelf, or rack rail mounting.
 - .2 A rack mount chassis shall be available for mounting and powering high density card versions of encoder/decoder units.
 - .1 Unit front panel shall indicate status of unit and installed cards.
 - .2 Unit front panel shall support network setup of installed cards.
 - .3 Unit shall support hot swappable card interchange.
 - .4 Rack chassis shall include a built-in 100-240VAC power supply.
 - .6 USB and KVM Functionality
 - .1 KVM routing shall not add additional latency to AV transmission.
 - .2 USB routing shall not add additional latency to AV transmission.
 - .3 USB and KVM routing shall be independent of AV routing.

Integrated Audio-Visual System

- .4 USB peripheral device switching functionality shall support:
 - .1 Whiteboards, Touch screens, Game controllers, Cameras, Mobile devices, Headsets, Flash drives
- .5 Encoder/Decoder USB ports shall be capable of linking with networked USB extender hardware by same manufacturer.
- .6 Encoder/Decoder Units shall include USB ports capable of linking to other Encoders and Decoders in the system.
- .7 Built-in USB ports:
 - .1 One (1) USB Type B port
 - .2 One (1) USB Type A port
- .7 Power supply modes:
 - .1 Local or remote DC power source.
 - .2 Remote power supplied UPoE switch or power injector from same manufacturer.
- .8 Device Control
 - .1 The Encoder/Decoder Unit shall include built-in RS-232 and IR control ports for control of the connected display or device.
- .9 Device Setup
 - .1 Encoder and Decoder units shall be configurable via a web browser or software tool provided by manufacturer.

2.12 Computer with Virtual Control Server Software

- .1 Virtual Control Server Software
 - .1 Software Functions:
 - .1 The control software shall allow network connected devices to be controlled and integrated into a pre-programmed system.
 - .2 The control software shall provide centralized server based control of multiple rooms containing multiple controlled devices.
 - .1 A single server when configured properly shall be capable of controlling up to 500 rooms.
 - .2 The control software shall act as a virtual control processor for connected devices.
 - .3 Additional hardware control processors shall not be required.
 - .3 The control software shall support control of non-network connected devices by use of interface modules by the same manufacturer.

Integrated Audio-Visual System

- .4 The control software shall support a cloud management service option by same manufacturer to facilitate the following functions:
 - .1 Device and network setting configuration
 - .2 Server control software license management
 - .5 The control software shall support an offline licensing option via USB storage device as referenced in section 2.2.
 - .6 The control software shall support server redundancy.
 - .7 The control software shall support security measures.
 - .8 The control software shall support development and deployment of a single control program across multiple rooms or systems.
- .2 Environment
- .1 The control software shall run on the following PC platforms:
 - .1 Processor Intel Core® i5-10500T CPU @ 2.30GHz
 - .2 RAM 8 GB DDR4 2666MT/s
 - .3 Storage 256 GB SSD
 - .4 Graphics Intel® UHD Graphics 630
 - .5 Network Intel I219-LM 100/1000 Mbps Ethernet
 - .2 OS
 - .1 AlmaLinux OS® 8.2 software (64-bit version)
 - .2 Rocky Linux™ OS 8.2 software (64-bit version)
- .3 Deployment
- .1 The control software shall support centralized deployment.
 - .1 A single deployment may support up to 500 rooms or systems.
 - .2 The control software shall support the following programming languages:
 - .1 C#
 - .2 SIMPL
 - .3 SIMPL#Pro
- .2 Control System License
- .1 The device shall support offline validation of control system licenses without a service account via USB connection to control system software host server.

Integrated Audio-Visual System

2.13 Audio DSP

.1 Audio Digital Signal Processor

.1 The Audio Digital Signal Processor (DSP) will be purpose built for professional use. Each DSP shall include an internal processor that will provide advance audio controls and shall operate with or without a control system.

.2 Physical

.1 The DSP's shall be in a 1RU EIA standard enclosure for rack mounting.

.2 Unit depth shall be 14.35 inches, 365mm

.3 Internal fan cooling shall provide side-to-side airflow.

.4 The DSP shall have a front panel bi-color LED to indicate unit status

.1 Connection to AC mains

.2 Connection to a LAN.

.5 The front panel Reset shall return the unit to the last saved configuration

.6 The rear panel LAN connector shall provide network communications

.7 The DSP shall include a Universal Power Supply

.1 Operational 50-60Hz, 100-240VAC.

.3 Communications

.1 The DSP's will be configured, monitored and controlled by the DSP software tool.

.2 The DSP software tool shall allow multiple instances to be active on a common network.

.3 The DSP software tool channel strip architecture will not require compiling in order to pass audio.

.4 Remote communications with the DSP software tool and Touch Panels by same manufacturer will be via standard Ethernet.

.1 shall support: 10/100/1000 Mbps, auto-switching, auto-negotiating, auto-discovery, full/half duplex, TCP/IP, UDP/IP, CIP, DHCP, SSL, SSH, SFTP (SSH File Transfer Protocol)

.5 The DSP shall provide a local Universal Serial Bus (USB) console port connection on a standard USB-B type connector.

.4 Audio I/O

.1 DSP 12X8 Type

.1 Shall provide 12 balanced input connections with selectable phantom power for condenser microphones.

.2 Shall provide 8 balanced output connections.

Integrated Audio-Visual System

- .2 DSP 8x6 Type
 - .1 Shall provide 8 balanced input connections with selectable phantom power for condenser microphones
 - .2 Shall provide 6 balanced output connections.
- .3 All Types
 - .1 Input connections shall be selectable for balanced line level analog audio signals on Phoenix style removable connectors.
 - .2 Each individual channel shall have its own dedicated connection.
 - .3 Analog to Digital and Digital to Analog Conversion
 - .1 24 bit, 48kHz
- .5 Audio Configuration
 - .1 The channel strip software shall be configurable for instant audio delivery without requiring configuration code compile.
 - .2 Presets shall recall any system configuration
 - .3 Views shall recall any system control screen configuration
 - .4 Channel Strips shall allow for the creation of unique configurations that are repeatable and portable.
 - .5 The Digital Signal Processor shall provide:
 - .1 Spectrum analyzer
 - .2 Gain controls (Input/Output)
 - .3 Any-to-Any Matrix Routing
 - .4 Matrix In/Out level trim
 - .5 Matrix crosspoint level
- .6 Filters for all models shall include
 - .1 Equalization
 - .2 Limiters
 - .3 Gates
 - .4 Compressors
 - .5 Crossovers
 - .6 Delays
 - .7 Hi Pass filters
 - .8 Low Pass filters
 - .9 Lo and Hi Shelf

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- .10 Gating style Auto Mixer
- .7 Auxiliary channel strips
 - .1 An additional 8 Auxiliary channel strips with comprehensive signal processing shall be provided.
 - .1 All Auxiliary Strips shall be routable to any Matrix crosspoint or output Bus.
- .8 DSP Type 4 and DSP Type 5 shall include:
 - .1 Acoustic Echo Cancellation on all 12 input channels
 - .2 Separate POTS connector RJ11
 - .3 Separate VoIP connector RJ45
 - .4 USB 2.0 audio 8x8 with type B connector
- .9 DSP Type 3 and DSP Type 5 shall include:
 - .1 Dante audio connectivity
 - .2 Separate Primary and Secondary Dante network ports, RJ45
 - .3 Front panel 5 segment LED indicators referencing:
 - .1 Microphone and line in
 - .2 Line Out
- .10 User Interface Export
 - .1 Touch Panels by same manufacturer shall integrate natively with the DSP for a rich graphic user interface.
 - .2 Graphic control elements will be selectable and exportable directly from the DSP software tool.
 - .3 The User Interface Export file shall enable the building of touch panels with a drag and drop process.
- .11 Compliance
 - .1 The DSP shall be UL listed, Commercial Audio Equipment
 - .2 Compliant with the RoHS directive.
- .12 Audio Digital Signal Processor
 - .1 The Audio Digital Signal Processor (DSP) will be purpose built for professional use. Each DSP shall include an internal processor that will provide advance audio controls and shall operate with or without a control system.
- .13 Physical
 - .1 The DSP's shall be in a 1RU EIA standard enclosure for rack mounting.
 - .2 Unit depth shall be 14.35 inches, 365mm

Integrated Audio-Visual System

- .3 Internal fan cooling shall provide side-to-side airflow.
- .4 The DSP shall have a front panel bi-color LED to indicate unit status
 - .1 Connection to AC mains
 - .2 Connection to a LAN.
- .5 The front panel Reset shall return the unit to the last saved configuration
- .6 The rear panel LAN connector shall provide network communications
- .7 The DSP shall include a Universal Power Supply
 - .1 Operational 50-60Hz, 100-240VAC.
- .14 Communications
 - .1 The DSP's will be configured, monitored and controlled by the DSP software tool.
 - .2 The DSP software tool shall allow multiple instances to be active on a common network.
 - .3 The DSP software tool channel strip architecture will not require compiling in order to pass audio.
 - .4 Remote communications with the DSP software tool and Touch Panels by same manufacturer will be via standard Ethernet.
 - .1 shall support: 10/100/1000 Mbps, auto-switching, auto-negotiating, auto-discovery, full/half duplex, TCP/IP, UDP/IP, CIP, DHCP, SSL, SSH, SFTP (SSH File Transfer Protocol)
 - .5 The DSP shall provide a local Universal Serial Bus (USB) console port connection on a standard USB-B type connector.
- .15 Audio I/O
 - .1 DSP 12X8 Type
 - .1 Shall provide 12 balanced input connections with selectable phantom power for condenser microphones.
 - .2 Shall provide 8 balanced output connections.
 - .2 DSP 8x6 Type
 - .1 Shall provide 8 balanced input connections with selectable phantom power for condenser microphones
 - .2 Shall provide 6 balanced output connections.
 - .3 All Types
 - .1 Input connections shall be selectable for balanced line level analog audio signals on Phoenix style removable connectors.
 - .2 Each individual channel shall have its own dedicated connection.

Integrated Audio-Visual System

.3 Analog to Digital and Digital to Analog Conversion

.1 24 bit, 48kHz

.16 Audio Configuration

.1 The channel strip software shall be configurable for instant audio delivery without requiring configuration code compile.

.2 Presets shall recall any system configuration

.3 Views shall recall any system control screen configuration

.4 Channel Strips shall allow for the creation of unique configurations that are repeatable and portable.

.5 The Digital Signal Processor shall provide:

.1 Spectrum analyzer

.2 Gain controls (Input/Output)

.3 Any-to-Any Matrix Routing

.4 Matrix In/Out level trim

.5 Matrix crosspoint level

.17 Filters for all models shall include

.1 Equalization

.2 Limiters

.3 Gates

.4 Compressors

.5 Crossovers

.6 Delays

.7 Hi Pass filters

.8 Low Pass filters

.9 Lo and Hi Shelf

.10 Gating style Auto Mixer

.18 Auxiliary channel strips

.1 An additional 8 Auxiliary channel strips with comprehensive signal processing shall be provided.

.1 All Auxiliary Strips shall be routable to any Matrix crosspoint or output Bus.

.19 DSP Type 4 and DSP Type 5 shall include:

.1 Acoustic Echo Cancellation on all 12 input channels

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- .2 Separate POTS connector RJ11
- .3 Separate VoIP connector RJ45
- .4 USB 2.0 audio 8x8 with type B connector
- .20 DSP Type 3 and DSP Type 5 shall include:
 - .1 Dante audio connectivity
 - .2 Separate Primary and Secondary Dante network ports, RJ45
 - .3 Front panel 5 segment LED indicators referencing:
 - .1 Microphone and line in
 - .2 Line Out
- .21 User Interface Export
 - .1 Touch Panels by same manufacturer shall integrate natively with the DSP for a rich graphic user interface.
 - .2 Graphic control elements will be selectable and exportable directly from the DSP software tool.
 - .3 The User Interface Export file shall enable the building of touch panels with a drag and drop process.
- .22 Compliance
 - .1 The DSP shall be UL listed, Commercial Audio Equipment
 - .2 Compliant with the RoHS directive.

2.14 Cloud Based Room Scheduling Software

- .1 Management Service
 - .1 The Cloud service shall allow all supported devices by the same manufacturer to be managed and configured from one central, secure location in the cloud.
 - .2 The Cloud service shall support monitoring 3rd party devices.
 - .1 Monitoring 3rd party devices shall utilize a Linux based cloud connector application by same manufacturer.
 - .3 The Cloud service shall support the following:
 - .1 Configure device and network settings
 - .2 Configure device licenses
 - .3 Update device firmware
 - .4 View device status
 - .4 The Cloud service shall be a multi-tenant, SaaS application

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- .5 The Cloud Service Application shall utilize a cloud computing service composed of a global network of Microsoft-managed data centers.
- .6 The Cloud Service application manufacturer shall be a Microsoft Partner.
- .2 Environment Organization
 - .1 The cloud service application shall support claiming of devices into an organized visual organizational hierarchy tree structure.
 - .2 The cloud service application shall support claiming of multiple devices via the use of a .csv file containing device information.
- .3 Deployment Functions
 - .1 The Cloud Service shall support the following device deployment functions:
 - .1 Configure devices remotely
 - .2 Troubleshoot devices remotely
- .4 Management Functions
 - .1 Room Capacity Monitoring
 - .1 Social Distancing Alerts
 - .1 Service shall support a people counting capability when managed room includes a unified communication system by same manufacturer.
 - .2 Room Capacity Dashboard
 - .1 Rooms equipped with Unified Collaboration system by same manufacturer shall support a dashboard indicating the percentage of time that the space spends in violation of preset
 - .2 The Cloud Service shall support the following management functions:
 - .1 Add and remove licenses
 - .1 Add or remove licenses for a group of devices
 - .2 Add or remove licenses for a single device
 - .2 Load a control system program
 - .1 Remotely load control system
 - .3 Schedule Actions
 - .1 Schedule actions for a group of devices
 - .2 Schedule actions for a single device
 - .4 Update settings and firmware remotely
 - .1 Change settings of a single device
 - .2 Change settings of a group of devices

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.5 Monitor Device Status

.1 View Status of a single device

.2 View status of a group of devices

.6 Provide System Dashboard

.1 Dashboards shall be interactive and contain different charts that can be cross-filtered by clicking on the chart and filters, including date range.

.7 Implement security updates

.8 Identify problems using audit logs

.1 Application shall log all changes

.9 Provide user management

.1 Application shall provide the ability to create users with different levels of access and permissions.

.10 Alerts

.1 Application shall be capable of sending SMS and email alerts.

2.15 Sound Bar with Integrated Video Camera (Optional for Small Meeting Rooms)

.1 Sound bar shall have integral Multi cameras with resolution of 13 megapixels

.2 Application shall Zoom Up to 6x loss less digital zoom

.3 Horizontal view must be : 180° and Vertical: 54° Field of view

.4 Camera shall support Panoramic-4K: 3840 x 1080 @ 30fps Resolution

.5 Application shall have Intelligent Zoom, Virtual Director, Vivid HDR

.6 Speakers must include woofers and tweeters.

.7 Speaker frequency range should be 80Hz - 20kHz

.8 Application must have Automatic Speaker Detection and Microphone type-8 microphone beamforming array.

.9 Microphone sensitivity shall be 37dBFS and frequency range-100Hz - 8kHz

.10 Windows 10, compatible with macOS 10.15 and later, including macOS 11.x Integrated PeopleCount, Whiteboard Sharing.

.11 USB-A, USB-C, Ethernet (RJ45) Connectivity Support 2.0, USB 3.0 USB versionsUSB

.12 Sound bar shall support Bluetooth Low Energy Support for remote control and Sound+ access.

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2.16 Ultra Short Throw Projector

- .1 The projector shall feature a laser light source with a long life of up to 20,000 hours and an ultra-short throw design with a 0.25 throw ratio.
- .2 It must be a native resolution of 4K UHD (3840 x 2160) and shall be HDR10 compatible.
- .3 The projector must be equipped with 3LCD technology and a 3,000 lumens color and white light output.
- .4 It must be able to display up to a 300" image with a 1.6x zoom and lens shift range.
- .5 It must feature an integrated stereo speaker system with a total of 20W output and should be compatible with Wi-Fi and Bluetooth for wireless communications.
- .6 The projector must be equipped with two HDMI ports, two USB ports, two VGA ports, and an RJ-45 port for networking.
- .7 Projection System: 3LCD, 3-chip technology
- .8 Projection Method: Front/rear/ceiling mount
- .9 Driving Method: Poly-silicon TFT Active Matrix
- .10 Aspect Ratio: 16:9 widescreen
- .11 Contrast Ratio: Up to 2,500,000:1
- .12 Color Processing: Full 10-bit
- .13 Lamp Type: Laser Diode 2x (blue laser, red laser)
- .14 Lamp Life: Up to 20,000 hours (ECO mode)
- .15 Keystone Correction: Vertical: ± 3 degrees
- .16 Lens Shift: Vertical: $\pm 60\%$, Horizontal: $\pm 24\%$
- .17 Projection Lens: Type: Optical Zoom (Manual)/Focus (Manual)
- .18 F-number: 1.5 – 1.9
- .19 Focal Length: 13.9 mm – 21.9 mm
- .20 Zoom Ratio: Optical zoom 1.0 – 1.6
- .21 Screen Size: 60" – 130"
- .22 Throw Ratio Range: 1.35 – 2.21 (16:9)
- .23 Projection Distance: 2.2' – 4.2'
- .24 Operating Temperature: 41 ° to 104 °F (5 ° to 40 °C)
- .25 Power Supply Voltage: 100 – 240 VAC $\pm 10\%$, 50/60 Hz

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2.17 Microphones

- .1 Wireless Microphone receiver
 - .1 Dimensions 1U rack mounted
 - .2 Frequency response: 30 Hz - 20 kHz (1.5 dB)
 - .3 THD, total harmonic distortion < 0.03 % (@ 1 kHz)
 - .4 Audio output:
 - .1 Digital Audio outputs: AES3-2003, XLR-3: 48 kHz, 96 kHz, 24 bit Dante™, RJ-45: 48 kHz, 96 kHz, 24 bit Can be externally synchronized using WCLK loop-through with BNC sockets
 - .2 Analog Audio Outputs: XLR-3 and 6.3 mm jack per channel (transformer balanced) -10 dBu to +18 dBu in steps of 1 dB (2 kΩ)
 - .5 Switching bandwidth: 244 MHz
 - .6 Power supply: 100 - 240 V AC, 50/60 Hz
 - .7 Antenna connector:
 - .1 Input 2x BNC (50 Ω), 12 V DC, max. 200 mA each via antenna sockets, short circuit proof, Output 2 x BNC (50 Ω)
 - .8 Codecs SePAC (Sennheiser Performance Audio Codec)
 - .9 Dynamic range: 111 dB (A) type
 - .10 Frequency range: 470 - 714 MHz
 - .11 Headphone output level: 6.3 mm jack, 2x 100 mW at 32 Ω
 - .12 Image rejection > 100 dB typ.
 - .13 Sensitivity: -100 dBm typ.
 - .14 Word clock: Input: BNC, 75 Ω Output: BNC, 75 Ω
 - .15 Sampling Rates: 48 kHz, 96 kHz
 - .16 Transmission method: Digital modulation, "LR" mode Min. frequency spacing for equidistant grid: 325 kHz
 - .17 Latency:
 - .1 Analog Audio Out: 3 ms
 - .2 Digital Audio Out: 3 ms (AES/EBU)
 - .18 Audio codec: SeDAC (Sennheiser Digital Audio Codec)
 - .19 Network protocol: IEEE 802.3-2002 (10/100 Mbit/s), shielded RJ-45 connection
 - .20 Encryption: AES 256

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- .21 Daisy chain outputs: 2x BNC (50 Ω) 0 dB +/- 0.5 dB amplification relative to antenna inputs
- .22 Receiving channels: 2
- .23 Daisy-chained receivers (RF): Max. 8 EM 6000 units
- .24 Dante™: IEEE 802.3 (1000 Mbit/s), shielded RJ-45 connection
- .2 Wireless Microphone Transmitter:
 - .1 Dimensions: Approx. 82 x 64 x 24 mm
 - .2 Compander: Sennheiser HDX
 - .3 THD, total harmonic distortion: $\leq 0.9\%$
 - .4 Weight: (incl. batteries) approx. 160 g
 - .5 Signal-to-noise ratio: ≥ 110 dBA
 - .6 RF output power: Max. 30 mW
 - .7 Switching bandwidth: up to 42 MHz
 - .8 Peak deviation: ± 48 kHz
 - .9 Nominal deviation: ± 24 kHz
 - .10 Operating time: Typically 8 h
 - .11 Modulation: Wideband FM
 - .12 Power supply: 2 AA batteries, 1.5 V or BA 2015 accupack
 - .13 Current consumption: at nominal voltage: typ. 180 mA with transmitter switched off: ≤ 25 μ A
 - .14 Input impedance: 40 k Ω , unbalanced / 1 M Ω
 - .15 Max. Input voltage: 3 V_{eff}
 - .16 Powering: 3 V battery / 2.4 V rechargeable battery
 - .17 Transmission frequency: Max. 1680 transmitting frequencies, adjustable in 25 kHz steps 20 frequency banks, each with up to 12 factory-preset channels, no intermodulation 1 frequency bank with up to 12 programmable channels
 - .18 AF frequency response: Mic: 80 – 18,000 Hz Line: 25 – 18,000 Hz
 - .19 Temperature Range: -10 °C to +55 °C
 - .20 Frequency stability: $\leq \pm 15$ ppm
- .3 Microphone:
 - .1 Connector: 3.5 mm jack
 - .2 Frequency response: 50 to 18,000 Hz
 - .3 Max. sound pressure level: 130 dB

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- .4 Cable length: approx. 1.60 m
- .5 Transducer principle: pre-polarized condensor microphone
- .6 Pick-up pattern: omni-directional
- .7 Sensitivity in free field, no load (1kHz):20 mV/Pa
- .8 Equivalent noise level: 36 dB
- .4 Boundary Microphone:
 - .1 Connector: XLR
 - .2 Type: condenser
 - .3 Polar Pattern: cardioid
 - .4 Frequency response: 50 to 17,000 Hz
 - .5 Max. sound pressure level: 118.8 dB
 - .6 Dynamic Range 96.2 dB
 - .7 Power Requirements 11 – 52 Vdc phantom, 2.0 mA
 - .8 Signal-to-Noise Ratio: 71.4 dB
- .5 Gooseneck Microphone:
 - .1 Type: Electret condenser
 - .2 Polar Pattern: cardioid
 - .3 Frequency response: 50 to 16,000 Hz
 - .4 Max. sound pressure level: 120 dB
 - .5 Dynamic Range 93 dB
 - .6 Power Requirements CVGD: 11–52 V DC, 2.0 mA
 - .7 Signal-to-Noise Ratio: 67 dB
- .6 Ceiling Array Microphone:
 - .1 Type: Ceiling array
 - .2 Frequency response: 180 to 17,000 Hz
 - .3 Max. sound pressure level: 93.25 dB
 - .4 Dynamic Range 82.25 dB
 - .5 Power Requirements POE class 0
 - .6 Signal-to-Noise Ratio: 83 dB
 - .7 Lobe Width: 35, 45, 55 degrees
 - .8 Channel count: 10

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.9 Sampling rate: 48kHz

.10 Bit depth: 24

2.18 Assistive Listening System

.1 FM Transmitter

- .1 The unit shall be a type of FM transmitter that shall have a Dante digital audio input.
- .2 It shall have a frequency response of 50 Hz to 15 kHz \pm 1.5 dB and shall have a distortion of less than 0.5% THD at 400 Hz.
- .3 The frequency stability of the transmitter shall be \pm 0.001% and it shall have a pre-emphasis of 75 μ S.
- .4 The FM+ Dante transmitter shall use FM modulation and shall have a deviation of \pm 75 kHz. It shall have an RF output of 100 mW typical and shall have a power supply of 100-240 VAC, 50/60 Hz with a power consumption of 10 W typical.
- .5 The operating temperature range for the transmitter shall be 32°F to 104°F (0°C to 40°C).
- .6 The connectors on the transmitter shall include two RJ45 connectors for Dante Ethernet in/out, one 3.5 mm mini jack for audio input, one 3.5 mm mini jack for audio output (monitor), one BNC connector for antenna (50 ohm), and one 2.1 mm DC power input (center positive).

.2 Receiver Charging Units

- .1 The Charging Unit shall be a 12-unit, drop-in battery charger and shall charge a maximum of 24 AA size NiMH batteries.
- .2 The charger unit shall be microprocessor controlled and enclosed in ABS plastic.
- .3 The charger shall be a timed charger at 16 hours, and will provide a maintain charge once the timer has completed its charging cycle. Each bay on the charger shall have a red LED indicating charging status. The LEDs shall be on constantly during charging and will blink indicating when batteries are fully charged.
- .4 The charger Charging unit shall be powered by an external switching power supply (90-240 VAC input; 5 VDC, 4A output) via a CD barrel connector.
- .5 The charger shall have CE approval, and be compliant with RoHS and WEEE regulations.

.3 Receiver Units

- .1 The receiver shall be encased in black, PC/ABS impact-resistant plastic with a hinged battery door.
- .2 The receiver shall be a body-pack style and include a detachable belt-clip for hands-free operation.

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- .3 The receiver shall have a 3.5mm stereo jack to accommodate stereo or mono low impedance earphones, headphones and neckloops.
 - .4 The receiver shall have a power button that is backlit indicating power is on.
 - .5 The receiver shall receive 17 preset wideband channels between 72-76MHz. Channel selection shall be made in the menu.
 - .6 The receiver shall have channel-lock capability.
 - .7 The receiver shall have a slide switch inside the battery compartment to select disposable Alkaline or NiMH rechargeable battery operation.
 - .8 It shall have charger contacts on the bottom of the receiver for use with Williams Sound drop-in chargers CHG 3512 and CHG 3502.
 - .9 The receiver shall operate up to 50 hours with two disposable AA Alkaline batteries (BAT 001-2) and up to 32 hours with two AA NiMH rechargeable batteries (BAT 026-2).
 - .10 The receiver shall provide a maximum output of 35mW at 16Ω with an earbud type earphone.
 - .11 The systems audio frequency response shall be 200Hz to 15kHz ± 3dB and the signal to noise ratio shall be 65dB min.
 - .12 The receiver sensitivity shall be 2μV or better at 12dB Sinad with squelch defeated.
 - .13 The receiver shall accept up to ±75kHz FM deviation and have a 75 μS de-emphasis time constant.
 - .14 The receiver shall have FCC, Industry Canada approvals and be compliant with RoHS and WEEE regulations.
- .4 Stereo Neck Loop
- .1 The Stereo Neck loop shall be a compact, lightweight and durable personal listening accessory designed to provide high-quality stereo sound to individuals with hearing aids, cochlear implants or other hearing devices equipped with a T-coil.
 - .2 The neck loop shall have an 18-inch cord length, 3.5mm stereo jack input and a 3.5mm mono jack output.
 - .3 It shall have an impedance of 8 ohms and a frequency response of 20 Hz - 20 kHz.
 - .4 The neckloop shall provide a maximum output of 80dB SPL and have a Total Harmonic Distortion (THD) of less than 2% at 100 Hz.
 - .5 The Neck loop shall have an operating temperature range of 32°F to 122°F (0°C to 50°C) and a storage temperature range of -4°F to 140°F (-20°C to 60°C).

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2.19 Display Screen

.1 Video Properties

- .1 Ultra HD (3840x2160) Minimum native resolution
- .2 OLED/QLED wherever available from an approved manufacturer or equal, or LED Technology otherwise.
- .3 HDR10 and HLG.
- .4 Minimum peak luminance: 350 cd/m²
- .5 Viewing angle (horizontal/vertical): 178°
- .6 For display size refer to drawings

.2 Display Properties

- .1 Shall have BYOD feature enabling the users to control and stream content from their mobile phones (IOS, Android, etc.) and laptops.
- .2 Smart TV, capable of streaming 4K content from the internet, with applications platform
- .3 Wireless connectivity (WLAN)
- .4 Storage capability/ USB archive
- .5 Anti-Glare, Anti-Reflective screen treatment
- .6 Operating Temperature --- 0° to 40°C (32° to 104°F)
- .7 Operating Humidity --- 20% to 90%, non-condensing
- .8 Power Save mode
- .9 Power Timer
- .10 Internal Power Supply
- .11 System management and control via Ethernet LAN

.3 Inputs and outputs

- .1 HDMI
 - .1 A minimum of 4 HDMI inputs
 - .2 HDCP Compliant
 - .3 Latest Version available
- .2 USB
- .3 Bluetooth
- .4 Audio out

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- .5 Ethernet/TCP-IP (RJ-45)
- .6 Infrared
- .4 Accessories:
 - .1 User's Manual, power cord and wireless remote control.
 - .2 Shall be provided with an approved mounting by the manufacturer
 - .3 Mounting brackets for wall mount and Custom Ceiling drop type (for Kitchen area).
- .5 Lectern Display screen (OPTIONAL)
 - .1 Video Properties
 - .1 Full HD (1920x1080) Minimum native resolution
 - .2 16.77 million Colors, HDR10 and HLG.
 - .3 Minimum peak luminance: 260 cd/m²
 - .4 Viewing angle (horizontal/vertical): 178°
 - .5 23" Diagonal Size
 - .6 10 projected capacitive touch points
 - .2 Display Properties
 - .1 Anti-Glare, Anti-Reflective screen treatment
 - .2 Operating Temperature --- 5° to 35°C
 - .3 Operating Humidity --- 20% to 80%, non-condensing
 - .4 Power Save mode
 - .5 Power Timer
 - .6 Internal Power Supply
 - .3 Inputs and outputs
 - .1 DisplayPort (HDCP1.3)
 - .2 DVI-D (HDCP1.4)
 - .3 D-Sub mini 15 pin
 - .4 USB 2.0: Type-B
 - .5 USB 2.0: Type-A x 2
 - .6 Headphones (Stereo mini jack) Input and Output
 - .4 Accessories:
 - .1 User's Manual, power cord and wireless remote control.

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2.20 Video Projector

- .1 Display Properties
 - .1 Display engine: 3-chip DLP Laser projector
 - .2 Brightness & Resolution: 15,000 ANSI lumens /4k-UHD (3840x2160) minimum resolution
 - .3 Contrast Ratio: 2200:1
 - .4 Laser optical engine
 - .5 Start-up Screen: Programmable, with menu mute/suppress and blue screen off settings, image adjusting/warping software available and included as necessary
- .2 Provide all components necessary to ensure a proper display of HDCP encoded content (latest version).
- .3 Minimum Inputs
 - .1 Control Terminal: RS232D-sub9x1, USBx1
 - .2 System management and control via Ethernet LAN – TCP/IP (RJ-45 jack)
 - .3 Video inputs: HDMI minimum
- .4 Lens
 - .1 0.9-1.1:1.0 lens type.
 - .2 The lens selection shall follow the throw ratio depicted from the distances and screen width shown on the plans and the actual site condition.
 - .3 Focal length sized so lens is zoomed no further than $\pm 20\%$ from center focal length.
 - .4 Interchangeable
 - .5 Powered focus
 - .6 Lens Shift: Vertical and horizontal

2.21 Motorized Projection Screen

- .1 Screen Size: refer to drawings
- .2 Motor Specification: UL certified, rated 220-240V AC, 60 Hz, three wire, instantly reversible.
 - .1 Projection Viewing Surface:
 - .2 Material: Matt White
 - .3 On Axis gain: 1.0.
 - .4 Viewing angle: 180-degree viewing cone.
 - .5 Resolution: 4K ready.

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- .6 Aspect ratio: 16:9
- .3 Controls:
 - .1 Single station control rated 230V AC, 60 Hz with 3-position rocker switch with cover plate to stop or reverse screen at any point.
 - .2 Multiple station control rated 230V AC, 60 Hz with 3-position rocker switches with cover plates to stop or reverse screen at any point. Automatic override allows only one signal to reach the motor when operated simultaneously.
 - .3 Low voltage control unit with three button 24V switches and cover plate to stop or reverse screen at any point, built-in RF receiver, built-in Video Interface Control trigger for 3V-28V, RS232, and dry contact relays.
 - .4 Low voltage 24V control unit with hand held RF remote three-button control switch to stop or reverse screen at any point, built-in RF receiver, built-in Video Interface Control trigger for 3V-28V, RS232, and dry contact relays.
 - .5 Low voltage 24V control unit with hand held IR remote three-button control switch to stop or reverse screen at any point, built-in RF receiver, built-in Video Interface Control trigger for 3V-28V, RS232, and dry contact relays.
 - .6 Key Operated power supply switch to control power to control system.
 - .7 Locking switch cover plate for limited access to three-position switch.
 - .8 Key operated 3-position control switch rated 230V AC, 60 Hz to stop or reverse screen at any point.
 - .9 3-position low voltage control switch with key locking cover plate rated 24V to stop or reverse screen at any point.

2.22 Recording PTZ Camera (for Kitchen)

- .1 Camera resolution: 4K Ultra HD (3840 x 2160 pixels) or higher.
- .2 Zoom capability: at least 10x optical zoom.
- .3 Pan and Tilt range: Full 360-degree pan and 180-degree tilt range.
- .4 Low-light performance: ability to capture clear images in low light conditions.
- .5 Audio: built-in microphone and supports Dante audio interface for high-quality audio transmission.
- .6 Control: supports PTZ control through various interfaces such as RS-232, RS-422, IP, and Dante Controller.
- .7 Mounting: supports both ceiling and wall mounting.
- .8 Power: PoE (Power over Ethernet) support.
- .9 Network connectivity: supports Ethernet connectivity for remote management and control.

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- .10 Compatibility: compatible with popular video conferencing platforms such as Zoom, Microsoft Teams, and Google Meet.

2.23 Dante AV Transceiver – for PTZ Camera

- .1 Audio interface: Dante audio interface for high-quality audio transmission.
- .2 IR remote control: supports IR remote control for easy camera control.
- .3 Control interface: supports PTZ control through various interfaces such as RS-232, RS-422, IP, and Dante Controller.
- .4 Network connectivity: supports Ethernet connectivity for remote management and control.
- .5 Power: PoE (Power over Ethernet) support.

2.24 Video Recorder (for Kitchen Camera)

- .1 Video resolution: supports 4K Ultra HD (3840 x 2160 pixels) or higher video resolution.
- .2 Video compression: supports H.264, H.265, or other advanced video compression technology to reduce file size and optimize storage.
- .3 Recording capacity: supports sufficient storage capacity to store recorded video for an extended period.
- .4 Redundancy: supports redundant storage, such as RAID or backup servers, to ensure data security and avoid data loss.
- .5 Recording modes: supports continuous recording, motion-triggered recording, and scheduled recording.
- .6 Search and playback: supports fast and easy search and playback of recorded video.
- .7 Access control: supports access control features such as user authentication, user roles, and access permissions.
- .8 Network connectivity: supports Ethernet connectivity for remote management and control.
- .9 Compatibility: compatible with the camera model and video conferencing platforms used in the classroom.

2.25 Bluray Player

- .1 Playback Capability
 - .1 DISC: BD-ROM, CD (CD-DA), CD-R / -RW, DVD+R, DVD+R Double Layer, DVD+RW, DVD-Audio, DVD-R, DVD-R Dual Layer, DVD-RW, DVD-Video, SA-CD (SA-CD / CD) Playback, Stereoscopic 3D (profile 5), Ultra HD Blu-ray

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- .2 VIDEO FORMAT: AVCHD Disc Format, Motion JPEG (.mov, .avi), MPEG-1 Video / PS (.mpg .MPEG, .mkv).VOB, .VRO, MPEG-2 Video / PS, TS (.mpg.MPEG, .m2ts, .mts, .mkv).VOB, .VRO, MPEG-4 / AVC (.mov, 3gp, .3g2, .3gpp, .3gpp2, .flv), MPEG-4 AVC (.mkv, .mp4, .m4v, .m2ts, .mts), VC1 (.m2ts, .mts, .mkv), WMV9 (.wmv, .asf, .mkv), Xvid (.avi, .mkv)
- .3 AUDIO FORMAT: AAC (.AAC, .mka), AIFF (.aiff, .aif), ALAC (.m4a), Dolby Digital (.ac3, .mka), DSD - DSDIFF / DSD (.dff, .dsf), FLAC (.flac, .fla), HEAAC v.1 / v.2 / level2, LPCM (.mka), Vorbis, WMA10 Pro, WMA9 Standard (.WMA)
- .4 PHOTO FORMAT: BMP (.bmp), GIF (.gif), JPEG (.jpg, .jpeg), MPO MPF 3D (.mpo), PNG (.png)

- .2 Network:

- .1 Built in WiFi

- .3 Input and Output

- .1 Analog Audio 2ch Output (s): 1 (Rear),
- .2 Ethernet Connection (s): 1 (Rear),
- .3 HDMI Output (s): HDMI2.0x1 (Rear) ,
- .4 HDMI1.4x1 (Rear, Audio only),
- .5 Optical Audio Output (s): 1 (Rear),
- .6 USB Input (s): 1 (Front)

2.26 Equipment Racks/Cabinets

- .1 Power Management

- .1 Configuration: AC power
 - .1 Provide rack-mounted power strips, with surge protection,] sized to power each device in the rack, plus 40% spare outlet quantity.
 - .2 Vertical power strips shall be mounted to rear rack rails.
 - .3 Power strips and conditioning devices shall be electrically bonded to the rack grounding lug.
- .2 Surge Protection Device (SPD) selected in accordance with IEC 62305 and IEC 61643-21 as part of a coordinated set of SPD's for the building. Refer to Division 26 Section "Surge Protection for Low-Voltage Electrical Power Circuits".

2.27 Wire, Cables and Wall/Floor Box

- .1 General Cable Requirements: Size and type as recommended in writing by system manufacturer unless otherwise indicated.

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- .2 Comply with the following Specification Sections – as applicable to power, control, data and video signal transmission cables:
 - .1 Division 26 Section “Low-Voltage Electrical Power Conductors and Cables.”
 - .2 Division 27 Section “Communications Horizontal Cabling (TIA).”
 - .3 Division 27 Section “IP-Based Television System (IPTV)”.
- .3 Plenum rated cables shall be provided for all areas unless otherwise indicated.
- .4 Fire Resistant Cables: For life safety installations interface. Refer to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".
 - .1 Use Fire-resistant cables Type FR4.
- .5 Grounding Components: Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems".
- .6 Cable Selection: Signal type shall be indicated on system schematic diagram.
- .7 Cables for A/V systems have been specified in accordance with North American Standards since A/V cables are widely available and specified as such in this field in the industry. Contractor may propose materials and systems that comply with alternative International Standards: for example European Standards (rather than North American Standards and UL listed products).
- .8 Alternative Standards may be considered when proposed in writing, complete with manufacturers’ specifications and associated revised Drawings.
- .9 Cable Types:
 - .1 Microphone and Line Level Analog Audio Cable:
 - .1 Single-pair, twisted, No. 22 AWG (0.762 mm diameter) stranded (7x30) tinned copper conductors, foil-shielded pair with 100 percent shield coverage.
 - .2 The pair is cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - .1 NFPA 70, Riser Rated, Type CMR, polypropylene insulation, PVC jacket.
 - .2 NFPA 70, Plenum Rated, Type CMP, FEP (Fluorinated Ethylene Propylene) insulation, Plenum PVC jacket.
 - .2 Multi-Channel Analog Audio Cable:
 - .1 Six-pairs, twisted, No. 22 AWG (0.762 mm diameter) stranded (7x30) tinned copper conductors, individually foil-shielded pairs with 100 percent shield coverage.
 - .2 Each pair is cabled on common axis with No. 22 AWG, stranded (7x30) tinned copper drain wire.
 - .3 Nominal /impedance: 50 ohms.

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- .4 NFPA 70, Type CM, polypropylene insulation, PVC jacket.
 - .1 Nominal conductor DCR: 52.5 ohms/km.
 - .2 Nominal shield DCR: 34.8 ohms/km.
 - .3 Nominal velocity of propagation: 66%
- .5 NFPA 70, Plenum Rated, Type CMP, FEP (Fluorinated Ethylene Propylene) insulation and jacket.
 - .1 Nominal conductor DCR: 52.5 ohms/km.
 - .2 Nominal shield DCR: 37.1 ohms/km.
 - .3 Nominal velocity of propagation: 69%
- .3 Low impedance Loudspeaker Cable:
 - .1 Single-pair, twisted, No. 12 AWG (2.388 mm diameter) stranded (65x30) bare copper conductors, PVC insulated.
 - .2 NFPA 70, Riser Rated, Type CL3R, overall PVC jacket.
- .4 High impedance Loudspeaker Cable
 - .1 Single-pair, twisted, No. 18 AWG (1.220 mm diameter) stranded (7x26) bare copper conductors, PVC insulated.
 - .2 NFPA 70, Type CMG, overall PVC jacket.
- .5 Analog / Digital Video Cable:
 - .1 Five coaxial conductors, RG6/U, No. 18 AWG (1.024 mm diameter) solid bare copper conductors, individually foil-shielded conductors with 100 percent shield coverage, tinned copper braid with 95 percent shield coverage.
 - .2 NFPA 70, Riser Rated, Type CMR, gas injected foam high density polyethylene insulation, overall PVC jacket.
 - .1 Nominal conductor DCR: 21.0 ohms/km.
 - .2 Nominal shield DCR: 9.9 ohms/km.
 - .3 Attenuation: 35 dB/100m at 3000 MHz.
- .6 Analog / Digital Video Cable:
 - .1 Five coaxial conductors, RG59/U, No. 20 AWG (0.813 mm diameter) solid bare copper conductors, individually foil-shielded conductors with 100 percent shield coverage, tinned copper braid with 95 percent shield coverage.
 - .2 NFPA 70, Riser Rated, Type CMR, gas injected foam high density polyethylene insulation, overall PVC jacket.
 - .1 Nominal conductor DCR: 32.8 ohms/km.
 - .2 Nominal shield DCR: 12.5 ohms/km.

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- .3 Attenuation: 45.3 dB/100m at 3000 MHz.
- .7 Analog / Digital Video Cable:
 - .1 Single coaxial conductor, RG59/U, No. 20 AWG (0.813 mm diameter) solid bare copper conductor, foil-shielded conductor with 100 percent shield coverage, tinned copper braid with 95 percent shield coverage.
 - .2 NFPA 70, Riser Rated, Type CMR, gas injected foam high density polyethylene insulation, overall PVC jacket.
 - .1 Nominal conductor DCR: 32.8 ohms/km.
 - .2 Nominal shield DCR: 12.5 ohms/km.
 - .3 Attenuation: 44.0 dB/100m at 3000 MHz.
 - .3 NFPA 70, Plenum Rated, Type CMP, foam FEP (Fluorinated Ethylene Propylene) Teflon insulation, Plenum PVC jacket.
 - .1 Nominal conductor DCR: 32.8 ohms/km.
 - .2 Nominal shield DCR: 10.5 ohms/km.
 - .3 Attenuation: 71.8 dB/100m at 3000 MHz.
- .8 Digital Audio Cable (110 Ohms):
 - .1 Single-pair, twisted No. 24 AWG (0.610 mm diameter) stranded (7x32) tinned copper conductors, foil-shielded pair with 100 percent shield coverage.
 - .2 Pair is cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - .3 Nominal impedance: 110 ohms.
 - .4 Nominal conductor DCR: 77.7 ohms/km.
 - .5 Nominal shield DCR: 62.0 ohms/km.
 - .6 Attenuation: 5.58dB/100m at 5MHz and 10.10 dB/100m at 25MHz.
 - .7 NFPA 70, Type CMG, nominal velocity of propagation: 76%, foam polyolefin insulation, PVC jacket.
 - .8 NFPA 70, Type CMP, nominal velocity of propagation: 78%, foam FEP (Fluorinated Ethylene Propylene) insulation, Plenum PVC jacket.
- .9 S-Video Cable:
 - .1 Two coaxial conductors, No. 30 AWG (0.305 mm diameter) stranded (7x38) tinned copper conductors, individually tinned copper-braid shielded conductors with 98 percent shield coverage.
 - .2 NFPA 70, Plenum Rated, Type CMP, foam FEP (Fluorinated Ethylene Propylene) Teflon insulation, Plenum PVC jacket.
 - .3 Attenuation: 57.7 dB/100m at 400 Hz.

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- .4 Nominal conductor DCR: 328.0 ohms/km.
- .5 Nominal shield DCR: 24.6 ohms/km.
- .6 Nominal velocity of propagation: 78%.
- .10 Multimedia Composite Control Cable:
 - .1 Two pair cable: one for data and one for power.
 - .2 Data: single-pair, twisted No. 22 AWG (0.762 mm diameter) stranded (7x30) tinned copper conductors, foil-shielded pair with 100 percent shield coverage.
 - .3 Data Pair is cabled on common axis with No.22 AWG, stranded (7x30) tinned copper drain wire.
 - .4 Power: single-pair, No. 18 AWG (1.207 mm diameter) stranded (16x30) tinned copper conductors unshielded.
 - .5 NFPA 70, Riser Rated: Type CMR, insulation: foam polyethylene (data), flame retardant PVC (power); overall flame retardant jacket.
 - .6 NFPA 70, Plenum Rated, Type CMP, insulation: foam FEP (Fluorinated Ethylene Propylene) (data), plenum PVC (power); overall Plenum PVC jacket.
 - .7 Nominal impedance of No. 22 AWG data pair: 100 ohms.
- .11 Multi-Mode OM4 Fiber Optic Cable
 - .1 NFPA 70, Plenum Rated, Type CMP
 - .2 Multimode fiber shall meet the requirements of EIA/TIA-492AAAC
 - .3 Multimode: 50 μ m (OM4)/125 μ m
 - .4 2 or 4 fiber strands with outer reinforced jacket
 - .5 Fibers shall have dual wavelength capability; transmitting at 850 and 1300 nm ranges.
 - .6 Maximum Attenuation: 3 dB/km at 850 nm and 1.2 dB/km at 1300 nm.
 - .7 Designed to deliver optimum performance for use in 4k AV signal distribution application.
- .12 Single Mode Fiber Optic Cable
 - .1 NFPA 70, Plenum Rated, Type CMP
 - .2 Multimode fiber shall meet the requirements of EIA/TIA-492AAAC
 - .3 Single mode: 8.3 μ m.
 - .4 2 or 4 fiber strands with outer reinforced jacket
 - .5 Fibers shall have dual wavelength capability; transmitting at 1310 and 1550 nm ranges.
 - .6 Maximum Attenuation: 0.3 dB per 300m at 1550 nm.

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- .7 Designed to deliver optimum performance for use in 4k AV signal distribution application.
- .13 Twisted pair Digital Video Cable (STP):
 - .1 NFPA 70, Plenum Rated, Type CMP
 - .2 Shield (SF/UTP) or Foiled (F/UTP) as recommended by the AV switcher manufacturer.
 - .3 Designed to deliver optimum performance for use in 4k AV signal distribution application.
 - .4 Capable of delivering 4k video, high quality audio, high speed internet, power and control signal.
- .14 HDMI cable:
 - .1 NFPA 70, Type CL3-rated
 - .2 Shall comply with HDMI version 2 specification minimum.
 - .3 High performance, high quality cable optimized for delivering 18Gbps at minimum of 3.5m.
 - .4 Certified for use with the approved system components.
 - .5 Designed to deliver optimum performance for use in 4k AV signal distribution application.
 - .6 Designed to transmit high-speed digital video and audio signals.
 - .7 Gold plated Contacts
- .15 RS-232 Control Cable:
 - .1 NFPA 70, Riser Rated, Type CL3R.
 - .2 Two pairs twisted shielded with overall shield
 - .3 22 AWG (0.664 mm) stranded (7x30) tinned
 - .4 Properties: 55pf/ft with OD=5mm
- .16 Other AV Cables
 - .1 Provide AV cable adapters as required per the product manufacturer requirements.

2.28 Conduits, Trunking, Enclosures and Fittings

- .1 Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch (483-mm) housing complying with ECA TIA/ECA-310-E and Division 27 Section "Communications Equipment Room Fittings (TIA)".

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.2 General Requirements for Conduits, Trunking, Boxes and Similar Fittings:

.1 Comply with the following Division 26 Specification Sections:

.1 "Raceways and Boxes for Electrical Systems".

.2 "Underfloor Raceways for Electrical Systems".

.2 Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations and shall carry the appropriate Degree of Protection (IP) as per IEC 60529 and Degree of Mechanical Shock Protection (IK) as per IEC 62262.

2.29 Special Tools and Kits

.1 The Contractor shall furnish any special installation equipment, tools, or kits necessary to properly complete the telecommunications system installation. This may include, but is not limited to, tools for pulling, splicing, terminating, and testing the cables, communication devices, stands for cable reels, cable wenchers, assembly and adjustment devices, etc.

PART 3 - EXECUTION

3.1 Installation

.1 General

.1 Verification of Conditions: Examine the areas to receive the works and the conditions under which the works would be performed. Contractor shall remedy conditions detrimental to the proper and timely completion of the works. Do not proceed until unsatisfactory conditions have been corrected.

.2 Before construction works commence, visit the site and identify the exact routing for all cable pathways and equipment placement. Verify all dimensions, locating the works and their relation to existing works, all existing conditions and their relation to the works and all obstructions and conditions, etc. affecting the completion and proper execution of the works as indicated in the project drawings and specifications.

.3 All equipment locations shall be coordinated with other trades and existing conditions to eliminate interference with required clearances for equipment maintenance and inspections and to the approval of the Engineer.

.4 Installing of all equipment/devices shall be endorsed by the manufacturers and as per their recommendation.

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- .5 All devices and associated fixation/connectivity components installed in wet environments shall be provided with the appropriate isolation and waterproofing installations measures to avoid any water infiltration/damage to the devices and their connections. Install cabling and equipment to facilitate maintenance and repair or replacement of equipment components. Provide easy, safe and code mandated clearances at equipment racks and enclosures, and other equipment requiring maintenance and operation. Coordinate with the Engineer the exact location and mounting height of all equipment in finished areas, such as A/V cabinets, equipment racks, termination equipment, communication and electrical devices. As much as practical, connect equipment for ease of disconnecting, with a minimum of interference with other installations.
 - .1 Where AV plates are flush mounted in work surfaces, coordinate the location and mounting with other AV devices, voice/data outlets, electrical receptacles, and furniture or millwork. Refer to device specifications for additional mounting requirements.
 - .2 Where display devices are mounted, coordinate the location of AV back boxes, voice/data outlets, and electrical receptacles with the exact mounting hardware to be installed for equipment support to provide clear access to cables and connectors.
 - .3 Where touch screens are surface mounted, coordinate location of cable routing with other AV devices, voice/data outlets, electrical receptacles, and furniture or millwork. Provide grommets as necessary for cable routing. Refer to device specifications for additional mounting requirements.
- .6 Coordinate ordering and installation of all materials and equipment having long lead times or having major impact on works by other trades so as not to delay the job or impact the schedule.
- .7 Prior to ordering equipment, the Contractor shall coordinate the frequencies of all wireless devices to prevent unwanted interaction between devices and rooms. This shall include, but shall not be limited to, wireless microphones, assisted listening system devices, wireless control panels, etc.
- .8 All accessories, including rack mounting hardware, power supplies, etc., shall be obtained from the original equipment manufacturer. Unless otherwise noted or specified, Third Party accessories shall not be used.
- .9 Follow AVIXA/Infocomm F502.01:2018 "Rack Building Audiovisual Systems" for rack building
- .2 Workmanship
 - .1 All labor must be thoroughly competent and skilled, and all work shall be executed in strict accordance with the best practice of the trades.
 - .2 Carefully lay out all works in advance and install in a neat and workmanlike manner in accordance with recognized good practices and standards and recommendations of National and Local authorities having jurisdiction.

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.3 Cables

- .1 A/V system cabling shall be installed in separate dedicated pathways.
- .2 Terminal blocks, boards, strips or connectors shall be furnished for all cables which interface with racks, cabinets, consoles, or equipment modules. No audio cables shall run directly to the audio patch panel jacks. Each audio patch panel shall be furnished with an audio terminal block; and all audio cables to and from the audio patch panel shall terminate on this block.
- .3 Cut all cables, except video cables (which must be cut to an electrical length), to the length dictated by the cable run.
- .4 Supply and install required terminal blocks, boards, strips, connectors or patch panels for all cables which interface with racks, cabinets, consoles, or equipment modules.
- .5 Observe proper circuit polarity and loudspeaker wiring polarity. Clearly label connections and wires as to function and polarity. Wires patch panels and connectors as follows:

WIRE	CONNECTOR	SIGNAL
RED OR WHITE	PIN #2	HI OR POS
BLACK	PIN #3	LO OR NEG
SHIELD	PIN #1	GROUND OR COMMON

- .6 Cables shall not be wired with a polarity reversal between connectors at either end. Take special care when wiring microphone cables to ensure that constant polarity is maintained.
- .7 All system wire, except spare wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means. No bare wire ends will be accepted.
- .8 Use heat-shrink type tubing to insulate and dress the ends of wire and cables, including a separate tube for the ground or drain wire.
- .9 Make all solder connections with rosin-core solder. Use temperature-controlled soldering irons rated at least 60 watts for all soldering work. No soldering guns, gas or butane, or temperature-unregulated irons will be allowed on the job site. (The presence of such soldering tools on the job site will constitute evidence of solder connections made with unauthorized tools and will be grounds for rejection of all solder connections in the system and the subsequent re-work of same.)

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- .10 Mechanical connections shall be made with approved crimp lugs of the correct size and type for the connection. Wire nuts will not be permitted. Attach each connector with the proper size controlled-duty-cycle ratcheting crimp tool approved by the manufacturer of the connectors.
- .11 Conventional non-ratcheting type crimping tools are unacceptable, and shall not be used on the job site. (The presence of such tools on the job site will constitute evidence of mechanical connections made with unauthorized tools and will be grounds for rejection of all mechanical connections in the system and the subsequent re-work of same.)
- .4 Equipment Modification
 - .1 Where existing equipment is to be modified, Contractor shall furnish materials and labor as necessary to modify or add to the equipment. Modifications shall be done neatly with factory parts and assemblies approved for the application. Modification shall in no way jeopardize the operation or compliance of existing equipment with any governing codes and regulations.
- .5 Grounding and Bonding
 - .1 Bond all new metallic cable shields and metallic supporting structures including A/V cabinets, racks, and projectors as required by the project documentation and according to the manufacturer's specifications.
 - .2 Ground all audiovisual devices and equipment per manufacturer's specifications and/or project documentation.
 - .3 Ensure that the grounding system is physically secured.
 - .4 All grounding conductors leaving the room shall be routed in a separate conduit from all other cabling, and shall terminate at the nearest ground source.
 - .5 System Ground: A single primary "system ground" shall be established for the systems in each particular area. All grounding conductors in that area shall connect to this primary system ground.
 - .6 The system ground shall be provided in the audio equipment rack for the area, and shall consist of a copper bar of sufficient size to accommodate all secondary ground conductors. A copper conductor having a maximum of 0.1 Ohms total resistance shall connect the primary system ground bar to the nearest approved electrical ground. The Contractor shall ensure that the A/V system ground bus is properly electrically bonded to the building grounding system.
 - .7 Secondary system grounding conductors shall be provided from all racks, audio consoles, and grounding point for the area. Each of these grounding conductors shall have a maximum of 0.1 Ohms total resistance.

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- .8 Audio Cable Shields: All audio cable shields shall be grounded at one end point only. There are no exceptions. For inter and intra-rack wiring, this requires that the shield be connected at one end only. For ungrounded portable equipment, such as microphones, the shield shall be connected at both ends but grounded at only one end.
 - .9 Video Receptacles: All video receptacles that are provided and installed by the Contractor shall be insulated from the mounting panel, outlet box, or wireway. Unless otherwise detailed herein, this shall be accomplished by using insulated-from-panel type receptacles.
 - .10 Audio Receptacles: All audio receptacles that are provided and installed by the Contractor shall be insulated from the mounting panel, outlet box, or wireway. Unless otherwise detailed herein, this shall be accomplished by using insulated-from-panel type receptacles.
 - .11 General: Because of the great number of possible variations in grounding systems, it shall be the responsibility of the Contractor to follow good engineering practice, as outlined above, and to deviate from these practices only when necessary to minimize crosstalk and to maximize signal-to-noise ratios in the audio, video, and control systems.
 - .12 All grounding items shall be installed in complete compliance with Division 26, Section "Grounding and Bonding for Electrical Systems".
- .6 Equipment
- .1 All equipment shall be firmly secured in place unless requirements of portability dictate otherwise.
 - .2 All equipment shall have an engraved plaque permanently affixed, denoting its function.
 - .3 Fastenings and supports shall be adequate to support their loads with a safety factor of at least three. All boxes, equipment, etc., shall be secured plumb and square.
 - .4 During the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors.
 - .5 To insure a proper finished appearance, Contractor shall furnish and install trim/escutcheon components at all conditions where A/V components pass through the finished ceilings. This shall include but shall not be limited to video projector supports, flat-panel display supports and any other component which is not
 - .6 specifically supplied with integral flanges/trim components; i.e. speaker mounts, assistance listening devices, etc.
 - .7 All trim components at the ceiling plane shall be finished to match the approved ceiling grid system components. The Contractor should obtain a sample, including any custom color information, or standard color numbers. All trim components shall be submitted to the Engineer for review and approval prior to fabrication.

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.7 Connectors

- .1 Unless otherwise noted, all video and computer video cables shall be terminated using seventy-five ohm (75 Ohm) connectors, with a captive center pin.
- .2 Connection Plate Receptacles
 - .1 Audio (microphone): XLR type.
 - .2 Audio (line level): ¼ inch diameter tip/ring/sleeve type, or as required by the intercom system. Jack shall be insulated from panel type.
 - .3 Audio (loudspeaker level): Neutrik "Speak-On" Type.
 - .4 Intercom: ¼ inch diameter tip/ring/sleeve type, or as required by the intercom system. Jack shall be insulated from panel type.
 - .5 Video: BNC type.
 - .6 DVI: DVI-I jack, isolated from panel type, with hex nuts.
 - .7 HDMI: HDMI type A.
 - .8 RF: "F" type. Receptacles shall be insulated from panel type.
 - .9 All connectors located on wall plates, or in other exposed locations, shall be recessed.

.8 Mounting

- .1 Equipment shall be held firmly in place with proper types of mounting hardware as recommended and/or supplied by the manufacturer. Mounting hardware provided with equipment shall be used when practical. This includes front and rear rack rails, angle brackets, and rack slide kits. The equipment shall be installed so that it ensures reasonable safety for the operator. Supply adequate ventilation for enclosed equipment items which produce heat.

.9 Mounting Heights

- .1 Coordinate locations of the following with mounting heights as indicated on drawings.
 - .1 Technical wall plates.
 - .1 A/V input/output connections
 - .2 LED and LCD displays connections
 - .3 Video projector connections
 - .4 Signage screens
 - .5 Cameras
 - .6 Wall mounted speaker boxes
 - .7 Other AV equipment's connections
 - .2 Control/scheduling panels.

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- .3 Pull boxes.
- .2 Install all technical panels plumb.
- .10 Cable Separation
 - .1 All cables shall be grouped according to the signals being carried. In order to reduce signal contamination, separate groups shall be formed for the following cable families:
 - .1 Power cables
 - .2 Control cables
 - .3 Video cables
 - .4 Audio cables carrying signals less than – 20 dBm
 - .5 Audio cables carrying signals between – 20 dBm and +20 dBm
 - .6 Audio cables carrying signals above +20 dBm
 - .2 As a general practice, all power cables and control cables shall be run on the left side of an equipment rack as viewed from the rear. All other cables shall be run on the right side of an equipment rack, as viewed from the rear.
 - .3 Route all cable and wiring within equipment racks, cabinets and millwork according to function, separating wires of different signal levels (microphone, line level, amplifier output, AC, control, etc.) by as much distance as possible. Neatly arrange, harness and bundle all cable with nylon ties.
 - .4 Cable separation of cables for runs greater than 7.5 m.
 - .1 Microphone Level: 300 mm from all other circuits.
 - .2 Line Level and Control: 300 mm from any circuit with signal of 20dB or greater than Line Level and Control cables.
 - .3 Speaker level circuits: 300 mm from other circuits.
 - .4 Video and Data: 300 mm from any circuit with signal of 20dB or greater than Video and Data.
 - .5 AC Power Circuits: 300 mm from all other circuits.
 - .5 Cable separation for cable runs within Equipment rack.
 - .1 Microphone Level: 50 mm from all other circuits.
 - .2 Line Level and Control: 50 mm from any circuit with signal of 20dB or greater than Line Level and Control cables.
 - .3 Speaker level circuits: 50 mm from other circuits.
 - .4 Video and Data: 50 mm from any circuit with signal of 20dB or greater than Video and Data.
 - .5 AC Power Circuits: 50 mm from all other circuits.

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3.2 Factory Acceptance Tests

- .1 The Factory Acceptance Tests shall be carried out in a hardware and software environment, which simulates the final configuration of the SYSTEM.
- .2 The Contractor shall carry out any Factory Acceptances Tests, in Manufacturer's factory itself, before any site delivery, in order to make sure that the SYSTEM of both hardware and software and the SYSTEM after integration of various sub-systems is able to satisfy site technical requirements of the equipment specifications.
- .3 Test Plan
 - .1 All tests are to be carried out, according to the methodology presented in the Test Plan which has been submitted by the Contractor and approved by the Employer.
 - .2 The tests are to cover every aspect related to the specification of the system and its operation; including, but not limited to, visual inspections, measurements, and operation.
 - .3 Some of the functional or performance tests, which cannot be conducted in a simulated environment, due to their nature and complications, may, subject to the Engineer's approval, be combined with the Site Acceptance Tests.
- .4 All Factory Acceptance Test Specifications shall be subject to configuration management and change control by the Contractor at every level.
- .5 The results of the Factory Acceptance Tests, together with any re-testing as a result of failure, shall be recorded and signed by the authorized personnel of the Contractor.
- .6 Factory Acceptance Tests shall not be witnessed by the Engineer and/or Employer and/or Employer.

3.3 Field Quality Control

- .1 Co-ordinate all the work with Division 23. The locations of starters, motors and associated equipment indicated on the Drawings are approximate and diagrammatic only. Co-ordinate with the work of the Mechanical Division Trade Sections to ensure proper location of equipment. The exact locations of conduit terminations at Mechanical units shall be determined from equipment manufactures' approved Shop Drawings. Conduits must be installed to enter only in the locations designated by equipment manufactures.
- .2 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- .3 Perform tests and inspections.
 - .1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

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- .4 Perform all tests and adjustments prior to the system demonstration and acceptance test.
- .5 Perform all tests and complete related checklists recommended by the related AV standards, including the ones recommended in ANSI/Infocomm 10:2013 "Audiovisual Systems Performance Verification" and ANSI/Infocomm A.102.01:2017 "Audio Coverage Uniformity in Listener Area".
- .6 Provide the test instrumentation such as, precision sound level meter, real time, audio frequency analyzer, dual trace oscilloscope, random noise generator, Impedance Bridge, etc. and as previously submitted and approved.
- .7 Provide permanent staff - trained personnel to perform the tests and to adjust and equalize the systems, there will be no exceptions.
- .8 Record test results.
- .9 Retest: Correct deficiencies identified by tests and observations and retest until performance requirements specified in Part 1 of this Specification are met.
- .10 Integrated Tests with Other Contractors
 - .1 Make equipment available for testing and demonstrating various features specified.
 - .2 Typical test segments shall include but shall not be limited to the following:
 - .1 Communication Tests performed for the serial or LAN interface to ensure that proper communication can be established between the interfacing systems.
 - .2 Point-to-Point Tests performed on the system equipment to the interfacing systems to verify the functionality and correct animation of each I/O point/command including alarm messages.
 - .3 Retesting: Correct deficiencies and retest until total system meets requirements of the Specifications and complies with applicable standards. Prepare written records of tests.
 - .4 Schedule testing with at least 14 days advance notice.
- .11 Audiovisual System will be considered defective if it does not pass tests and inspections.
- .12 Prepare test and inspection reports.
 - .1 Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.
- .13 Experimental Period: As described under "WARRANTY" Article. Demonstrate successful operation to confirm, to the satisfaction of the Engineer, that the system is free of remarks and is ready for taking-over.

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3.4 Contractor System Checkout

- .1 Before Acceptance Tests are scheduled, the Contractor shall perform his own system check-out. He shall furnish all required test equipment and shall perform all works necessary to determine and/or modify performance of the system to meet the requirements of this Specification. This work shall be carried out in accordance with Contractor's Test Plan that has been approved by the Employer.

3.5 System Acceptance Tests

- .1 System Acceptance Tests shall not be performed until the Contractor's System Checkout has been completed and the test results have been reviewed. The System Acceptance Tests shall be supervised by the Engineer and shall consist of the following:
 - .1 A physical inventory shall be taken of all equipment on site and shall be compared to equipment lists in the Contract documents.
 - .2 The operation of all system equipment shall be demonstrated by the Contractor.
 - .3 Both subjective and objective tests shall be required by the Engineer to determine compliance with the specifications. The Contractor shall be responsible for providing test equipment for these tests.
 - .4 All final, "as-built" drawings, run sheets, manuals, and other required documents, as detailed in Part I of this Specification, shall be on hand.
- .2 In the event that further adjustment is required, or defective equipment must be repaired or re-placed, tests may be suspended or continued at the option of the Engineer.
- .3 Any charge for additional time incurred by the Engineer required overseeing the system tests, due to improper system installation or previous failed systems shall be the responsibility of the Contractor.
- .4 Experimental Period: as described above under "Warranty and Maintenance" article. Demonstrate successful operation to confirm, to the satisfaction of the Engineer, that the system is free of remarks and is ready for taking-over.

3.6 Demonstration And Training

- .1 Train Employer's maintenance personnel to configure, program, adjust, operate, and maintain SYSTEM equipment. Refer to Division 01 Section "Demonstration and Training."
 - .1 Train Employer's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
 - .2 Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.

END OF SECTION

PAVA & BGM System

PART 1 - GENERAL**1.1 Summary**

- .1 The contractor shall supply, install, test, commission, guarantee and maintain a completely new public address Voice Evacuation and Background music system consisting of control console, digital signaling audio processor (Software Pre-amplifier, matrix, feedback killer and equalizer) ,power amplifiers, desktop paging microphone, loudspeakers, CD player, music server, AM/FM tuner, volume controller and channel selector units, battery charger /power supply and all necessary interconnecting power, control, cabling, conduiting, cable trays etc. and confirming to EN54 part 16 and Local Civil Defense authority
- .2 Contractor shall coordinate all installation activities and details with the Employer's Information Technology Provider including final configurations.
- .3 Contractor shall provide all system documentation and submittals.
- .4 Contractor shall provide warranty and maintenance support as specified.
- .5 Contractor shall provide all calculations and/or analysis to support design and engineering decisions as specified in Submittals.
- .6 Contractor shall provide and pay for all labor, materials, and equipment. Pay required tax, gross receipts, and other taxes.
- .7 Contractor shall secure and pay for plan check fees, permits, fees, and licenses necessary for execution of Work as applicable for the project.
- .8 Contractor shall give required notices.
- .9 Contractor shall perform pre-delivery testing, site testing, and adjustment of the completed installation. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing.
- .10 Contractor shall comply with all codes, ordinances, regulations, and other legal requirements of public authorities that bear on performance of Work.
- .11 Contractor to provide alternate price for installation, configuration, and testing of equipment provided by the Employer
- .12 Employer reserves the right to procure the required equipment directly and provide it to the Contractor for installation, configuration, and testing.
- .13 The Contractor shall verify space, power and cooling requirements associated with this section.

PAVA & BGM System

- .14 The Tenderer shall provide a line by line compliance statement for all items in the specification. For any items which partially comply or do not comply, the tenderer shall clearly state the reason and details for the partial and/or noncompliance.
- .15 Related Drawings:
 - .1 PAVA/BGM Layout Drawings
 - .2 PAVA/BGM schematic diagram /Block Diagram Drawings
- .16 Related work specified elsewhere:
 - .1 Converged Network System Section 272000
 - .2 Structured Cabling System Specification Section 271000
 - .3 Section 284600- Fire Alarm System
 - .4 Coordination and interface with other trades and authorities having jurisdiction.

1.2 References

- .1 Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean reference to the latest printed edition of each.
- .2 Local Construction Codes and Regulation
- .3 Local Electrical Authority (Guidelines)
- .4 Local Telecommunication Authority (Guidelines)
- .5 Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual (TDMM) standards.
- .6 Institute of Electrical and Electronic Engineers (IEEE) standards
- .7 BS EN 61672-1 : Sound Level Meters
- .8 BS 5839 Part-8: Voice Alarm System
- .9 EN 54 Part-16: Sound Systems for Emergency Purposes
- .10 NFPA-72: National Fire alarms and signalling code
- .11 IEC 62368-1: 2014: Electrical Equipment Scheme.
- .12 ANSI/ AVIXA 2M-2010, Standard Guide for Audiovisual Systems Design and Coordination Processes
- .13 ANSI/ AVIXA 1M-2009, Audio Coverage Uniformity in Enclosed Listener Areas
- .14 INFOCOMM 8M-201X, Audio System Spectral Balance

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1.3 System Description**.1 PAVA and Background Music:**

- .1 The Contractor shall supply, install, test, commission, guarantee and maintain a completely new public address and voice evacuation and Background music system consisting of the control console, digital signalling audio processor (Software Pre-amplifier, matrix, feedback killer and equalizer), power amplifiers, desktop paging microphone, loudspeakers, battery charger /power supply and all necessary interconnecting power, control, cabling, conducting, cable trays, etc. and conforming to EN54 part 16 and Local Civil Defence authority
- .2 The complete installation is to conform to the applicable sections of NFPA-72, EN54-part 16, BS5839/8, and local civil defence fire code.
- .3 The number of the PAVA racks shall be provided as shown on PAVA drawings. The final location of all PAVA racks shall be coordinated on-site and as per the Engineer's instruction.
- .4 The zoning of each area shall be as required by the detailed design and as indicated in the PAVA/BGM system schematic diagram.
- .5 The installation shall be suitable for making complete site broadcast and it shall be possible to individually select each or all subsystems for site broadcasting purpose on selection of any area and before an announcement is made a scheme sound shall sound.
- .6 The system shall have enough no. of power amplifiers for the calculated connected load at rated power (no amplifier shall be loaded more than 80% of its rated capacity, provide slave amplifiers to meet the additional power requirement) and provide 20% spare capacity for future expansion. Ventilation panels to be provided between every amplifier mainframe for proper air circulation and cooling. Provide additional exhaust fans to achieve proper ventilation if required due to site conditions.
- .7 All the PAVA Headend equipment including battery charger shall be approved as one system under single third-party laboratory listing and single certification approval Like LPCB or Kite mark or Vds or CNBOP -PIB or Telefiction B.V or Intertek. Any mix listing for headend products under EN54 Part 16 shall be clear breach and shall be rejected. The EN54 Part 4 Charger unit shall be tested under the same certification to confirm the unit's compatibility with the EN54 Part16 approved product range. Separate certification for the PAVA charger tested as a standalone unit under EN-54 part4 shall not be accepted.
- .8 The PAVA system shall be interlinked with the fire alarm system to mute the music in case it is applicable) during the fire scenario.
- .9 The public address, voice evacuation and BGM system main rack shall feature at least N zones as per the schematic diagram.

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- .10 Each zone should be covered by Class-A or Class-AB circuits for redundancy purposes.
- .11 In case of Alarm, each floor should act as a one fire alarm zone regardless of the number of Circuits
- .12 Desktop emergency paging microphone, high quality pre-recorded alert, evacuation, test messages and security announcement should be installed at security room, control room and receptions.
- .13 A fully monitored, processor-driven, DSP-based controller system shall route the signals as required and monitor the connected amplifiers and loudspeaker circuits.
- .14 The monitoring facilities should be unaffected by the presence of audio and operate using standard loudspeakers. DC Monitoring is not acceptable.
- .15 Each remote rack shall contain DSP Audio Controller and Separate amplifiers; Systems consist of main DSP Audio Controller located in main master rack and distributed amplifiers without physical separate controllers in remote rack shall not be accepted solution. Failure of any master controller shall not lead to failure of the matrix/cause and effect of other nodes/remote racks. Each speaker circuit shall have dedicated physical hardware channel amplifier. Switching concept shall not be accepted
- .16 The pre-recorded messages shall be stored in all controllers (nodes) and not centralized in a server. All the amplifiers, speaker circuits, emergency paging microphone and main audio unit should be fully monitored.
- .17 The central equipment will be housed in 19" equipment racks supplied complete with lockable glazed front doors. Cable access shall be via the top of the racks, with labelled DIN-rail mounted terminals fitted at the rear. Wall mount PAVA panels shall not be accepted.
- .18 The system shall include the following inputs, listed in priority order where the lowest number represents the highest priority:
 - .1 Emergency desktop paging microphone (live paging)
 - .2 Pre-recorded evacuation message
 - .3 Pre-recorded alert message
 - .4 Pre-recorded test start message
 - .5 Pre-recorded test complete message
 - .6 Security announcement
 - .7 Any other music sources

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- .19 The evacuation, alert and test messages shall be digitally stored within the router units. Broadcast of these messages shall be controlled automatically by the fire alarm system, or manually from the emergency microphone. When triggered by the fire alarm system, the messages will require a separate 'de-latch' command to cease broadcast. Following BS 5839, EN54 part 16 and NFPA72, messages triggered in this manner cannot be silenced from the emergency microphone.
- .20 The message system shall have the following features:
 - .1 30 minutes minimum capacity
 - .2 16kHz sampling rate
 - .3 16 Bit sampling depth
 - .4 WAV file compatibility
 - .5 Message re-programming only with external PC

1.4 Submittals

- .1 Refer to contract documents for procedures.
- .2 Acoustic Simulation study based on EASE modeling for all typical areas must be submitted.
- .3 Construction Schedule
 - .1 The Contractor shall provide a time scaled Construction Schedule indicating general project deadlines with specific dates relating to the installation of the system. At a minimum, this Construction Schedule shall include the following milestones per floor:
 - .1 Cabling Procurement Date
 - .2 Equipment Procurement Date
 - .3 Cabling Installation Start Date
 - .4 Cabling Installation Completion Date
 - .5 Equipment Installation Start Date
 - .6 Equipment Installation Completion Date
 - .7 Equipment Testing Start Date
 - .8 Equipment Testing Completion Date
 - .9 Potential Slippage Periods
 - .10 Contingent Tasks
 - .11 Concurrent Tasks
 - .12 Completion of Documentation

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.4 Test Reports

- .1 Provide test reports prepared in accordance with CONSULTANT requirements. Provide other test reports necessary to establish the adequacy, quality, safety, completed status, and suitable operation of each system

.5 Detailed AV Network Map

- .1 The Contractor shall provide a detailed network map to be utilized as a road map during the implementation of the AV System. This map shall show all segments, all interconnects between segments and all active network devices.

.6 Submittal

.1 Product Data

- .1 By submitting complete product data and samples, the Contractor represents that they have carefully reviewed and verified materials, quantities, field measurements, and construction criteria related herein. It also represents that the Contractor has checked, coordinated and verified that information contained within project drawings, product data sheets and samples conform to the requirements of the work and of these specifications. The Contractor shall notify in writing of any irregularity or discrepancies to the Consultant and provide the Consultant with possible solutions that will rectify any situations.
- .2 Submit catalogue data sheets, neatly bound with title page, space for submittal stamps, and tabbed dividers between sections. List all proposed equipment with reference to corresponding specification paragraph numbers or equipment title. Indicate all accepted substitutions.
- .3 Submit a schedule of finishes indicating proposed materials and color selections for all exposed items subject to Consultant selection.
- .4 Submit a list showing coordination of selected frequencies for all wireless transmitters.

.2 Shop Drawings

- .1 Submit point-to-point wiring diagrams and typed wire lists identifying every connection for information. Include electronic devices such as switches, transformers, and terminal blocks. Indicate locations of all components. Identify cables by types, colors, and wire numbers.
- .2 Submit system plans showing all device locations and ceiling distributed loudspeaker layouts. Perform Required Electrical Power calculations to achieve 85 dB SPL at 1.6 meters AFF for each loudspeaker type and mounting location and show wattage tap settings on the plans. Perform loudspeaker circuit impedance calculations and note anticipated line impedance for each loudspeaker circuit based on the selected taps.
- .3 Submit conduit riser diagrams showing connection of all devices, required conduit sizes along with types and quantities of cables to be used and cable identification tags.

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- .4 Submit Power and cooling requirements for each equipment rack / room.
 - .5 Submit rack layouts indicating the proposed arrangement of mounted equipment including junction boxes and locations of conduit penetrations.
 - .6 Submit fully dimensioned construction details of all panels, plates and other custom fabricated items or modifications (e.g. installation of audio/visual equipment in lecterns). Include complete parts lists and, as required, schematic diagrams.
 - .7 Submit mounting and support details for distributed ceiling loudspeakers, loudspeaker arrays, video projectors and displays, and all other items mounted overhead complete with parts lists and dimensions. Include a full plan view, front elevation, and side elevation of each item with corresponding support structure and mounting hardware. Verify load ratings of all hanging components including attachment hardware. Verify finish and color of all exposed loudspeakers, loudspeaker trim and loudspeaker grilles (subject to approval by Architect).
 - .8 Submit electronic copies of any custom programming including source codes. Include printed copies of all control screens, wiring pages, etc.
 - .9 Submit Control Panel Layouts for each area / room.
- .7 Shop Drawings & Product Data.
- .1 Maintain a full set of Shop Drawings at the Project site marked up to indicate actual locations, wattage tap settings and, in general, the true state of the installation. Furnish one initial set of shop drawings along with the results of all source quality control tests and field quality control tests to the Consultant for use during acceptance testing and equalization.
 - .2 Transportation media shall be in IBM-type structure on DVD-ROM or CD-ROM format.
 - .3 A Master File List in text format shall be placed on each CD ROM with a short description of files in the submittal.
 - .4 The shop drawings shall be in AutoCAD R2010 or later drawing (.DWG) format. Drawing Exchange File Format (.DXF) is not acceptable. All XREFs, fonts, and other drawing parts necessary shall be included.
 - .5 Word processing files shall be in latest MS Word format. Graphs and charts shall be in MS Excel format. Any graphic images necessary for the reproduction of the submittals shall be included in the files, and shall be included in JPEG (.JPG) file format.
 - .6 Manufacturers' data sheets, equipment manuals, and other documentation provided by the Manufacturers to the Contractor or documents that are similarly not otherwise available to the Contractor in electronic format shall be excluded from this requirement.
- .8 Contractor is solely responsible for quality control of the Work.

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- .9 Comply with applicable requirements of the laws, codes, ordinances and regulations of the authorities having jurisdiction. Obtain necessary approvals from all such authorities.

1.5 Close-Out Submittals

- .1 Upon completion of the installation, Contractor shall prepare as built documentation of the entire installation. This documentation should include:
 - .1 Electronic Copies
 - .2 Operation Manual
 - .1 Neatly bind each with tabbed dividers between sections and include a title page with space for submittal stamps.
 - .2 Table of Contents
 - .3 Typed description of each system including key features and operational concepts (e.g. remote control features, switching or routing functions, patch points, mixing and linking capabilities).
 - .4 Setup diagrams and typed instructions for use in typical situations as directed by the Consultant.
 - .5 Small scale plans (no smaller than half size) showing locations and circuit numbers for all system outlets and receptacles.
 - .6 Single-line block-diagrams showing all major system components.
 - .7 Two sets of half size drawings showing the components and wiring in each individual rack. One drawing of each rack shall be mounted in a plastic jacket to the rear door of the associated rack. The other complete drawing set shall be included in the manual.
 - .8 Manufacturer's operation manuals for equipment intended for operation by system users.
 - .9 A properly licensed working copy of the latest version of any and all software required to operate or configure the systems specified herein shall be a part of the system supplied. This includes, but is not limited to, all software, firmware and hardware required for configuration, adjustment, diagnosis and repair.
 - .10 All software shall be fully documented, and that documentation included.
 - .11 Software shall be included in its "installable" state on industry standard CD-ROM, or other appropriate format. Back-up of the working software may be provided as an additional inclusion. Disk images are unacceptable.
 - .12 Any and all user definable software configurations and/or programming shall become the sole property of the employer. This includes all source code, source code copyrights, and related documentation.
 - .13 The compiler shall be property of the employer with all related documentation.

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- .14 Key schedule cross referencing all keys to their respective functions.
- .3 Maintenance Data Manual
 - .1 Neatly bind each with tabbed dividers between sections and include a title page with space for submittal stamps.
 - .2 Table of Contents
 - .3 Company name, address, telephone number and contact name for system service or maintenance.
 - .4 Listing of all equipment and materials with names of manufacturers and model numbers or part numbers.
 - .5 Catalog data sheets displaying manufacturer's names, addresses, and telephone numbers.
 - .6 Product manufacturers' warranties and a typed system warranty explicitly covering all materials and labor.
 - .7 Manufacturers' service manuals for all major equipment items.
 - .8 Test documentation showing results of source quality control tests, field quality control tests, acceptance testing, and equalization. Document final settings for all non-user devices and controls after completion of acceptance testing and equalization including raw and equalized house curves. Document the physical position of settings as well as input and output signal levels measured in dBu.
 - .9 Provide a recommended preventative maintenance schedule with reference to the applicable pages in the manufacturer's maintenance manuals. Where inadequate information is provided by the manufacturer, provide the information necessary for proper maintenance.
- .4 Drawings
 - .1 Submit as-installed point-to-point wiring diagrams and typed wire lists identifying every connection for information. Include electronic devices such as switches, transformers, and terminal blocks. Indicate locations of all components. Identify cables by types, colors, and wire numbers.
 - .2 Submit system plans showing all as-installed device locations, ceiling layouts, and loudspeaker tap settings.
 - .3 Submit conduit riser diagrams showing as-installed connection of all devices, required conduit sizes along with types and quantities of cables and cable identification tags.
 - .4 Submit results of system testing in spreadsheet form including loudspeaker circuit line impedance measurements, plate and panel connectivity with results of continuity testing of all wiring, RF levels measured at each termination, etc. as appropriate to the systems included in this specification.

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- .5 Submit loudspeaker coverage measurements on plans taken during field testing and commissioning.
- .6 Submit rack layouts indicating the as-installed arrangement of mounted equipment including junction boxes and locations of conduit penetrations.
- .7 Submit as-installed fully dimensioned construction details of all panels, plates and other custom fabricated items.
- .8 Submit electronic copies of all custom programming including as-installed source codes.
- .9 Submit as-programmed Control Panels/Page Layouts for each area / room.

1.6 Coordination

- .1 It is contractor's delegated design responsibility to carry out the work in accordance with the Employer requirements not limited to Contract Drawings and Specifications.
- .2 The measurements and dimensions shown on these drawings shall be verified at the site by the Contractor. The contractor shall be responsible for all dimensions and coordinated execution of the Work, where there are discrepancies in the contract documents [the Contractor shall] notify the Engineer before proceeding with the Work.
- .3 The Contractor shall supervise and organize the work using best skills and attention. Contractor shall be solely responsible for all construction means, methods, techniques, and sequences and procedures and for coordinating all portions of the Work under the Contract.
- .4 By the approval of Shop Drawings and Samples, the contractor thereby represents that all field measurements are determined and verified. The field construction criteria, materials, catalog numbers and similar data must be checked and coordinated in each Shop Drawing and Sample with the requirements of the Work and of the Contract Documents.
- .5 The Contractor shall check the drawings and schedules, shall coordinate them (by means of coordination drawings wherever required) with the work of all trades involved before submission and shall indicate thereon his approval. Drawings and schedules submitted without evidence of the Consultants approval may be returned for resubmission.
- .6 Mock-ups shall be constructed to verify selections made under sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances.
- .7 All Speakers shape and mounting height should be coordinated with the Architect.
- .8 Contactor shall coordinate the other contractors for integration with the Fire Alarm, Voice Evacuation, IPTV, BGM, BMS, Lighting control system and other building automation systems.

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1.7 Quality Assurance

.1 General

.1 Design, manufacture, testing and method of installation of all apparatus and materials furnished under the requirement of this specification shall conform to the latest publications or standard rules of the following:

- .1 British Standards.
- .2 European Norm
- .3 Local civil defence code
- .4 NFPA 72

.2 Vendor Qualifications

.1 The manufacturer shall be an ISO 9001 and ISO14001 certified. ISO Certification for the Subsidiary/Regional office shall not be considered as an alternative to the main manufacturer Certificate. Any Manufacturer does not carry the above certification will be rejected.

.2 The proposed headend electronics equipment shall be manufactured originally by the same proposed vendors. OEM branded headend products including amplifiers, Microphones and controllers shall not be accepted. A letter of conformity shall be submitted from the manufacturer's headquarters and not from subsidiary regional offices confirming the manufacturing source and address of proposed equipment.

.3 Codes and Standards

.1 All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities having jurisdiction. Such codes, when more restrictive, shall take precedence over these plans and specifications. The specifications and standards listed below form part of this specification. The system shall fully comply with the latest issue of these standards, if applicable

- .1 BS EN 61672-1 : Sound Level Meters
- .2 BS 5839 Part-8: Voice Alarm System
- .3 EN 54 Part-16: Sound Systems for Emergency Purposes
- .4 NFPA-72: National Fire alarms and signalling code
- .5 IEC 62368-1: 2014: Electrical Equipment Scheme.

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- .2 All the PAVA Headend equipment shall be approved as one system under single third-party laboratory listing and single certification approval Like LPCB or Kitemark or Vds or CNBOP -PIB or Telefiction B.V or Intertek. Any mix listing for headend products under EN54 Part 16 shall be clear breach and shall be rejected. The EN54 Part 4 Charger unit shall be tested under the same certification to confirm the unit's compatibility with the EN54 Part16 approved product range. Separate certification for the PAVA charger tested as a standalone unit under EN-54 part4 shall not be accepted.
- .4 Contractor is solely responsible for quality control of the Work.
- .5 Project drawings will be available to all parties involved in the work as the basis for construction and installation. Drawings provided will be to industry standard scale; however, all distances, clearances, lengths, routes, and equipment placements must be field verified prior to execution or placement.
- .6 Intent of Drawings:
 - .1 Project drawings will be available to all parties involved in the work as the basis for construction and installation. Drawings provided will be to industry standard scales; however all distances, clearances, lengths, routes, and equipment placements must be field verified prior to execution or placement.
 - .2 The Contract Drawings are diagrammatic and conceptual and do not show all components, materials, and other specific elements, which may be required for proper installation. It is the responsibility of the Contractor for coordinating the final equipment layout and pathway routing. If any departure from the Contract Drawings or the specifications is deemed necessary, details of such departures or conflicts shall be submitted in writing.
- .7 Mock-Up: Provide a mock-up as directed by the Consultant. Utilize the same materials and installation methods in the mock-up as intended for the final Work. Schedule the installation so that the mock-up may be examined, and any necessary adjustments made, prior to commencing fabrication of the Work. Replace unsatisfactory items as directed. When accepted, mock-up shall serve as the standard for materials, workmanship, and appearance for such Work throughout the project.
- .8 Maintain a full set of Shop Drawings at the Project site, indicating actual locations, routing and, in general, the true state of the installation.
- .9 Alternates and Substitutions:
 - .1 Refer to Contract Documents for Alternates and Substitutions.
 - .2 Specific part numbers may be identified within these specifications to relay the level of quality and capabilities desired and establish a baseline for operation, function and performance. Only material or equipment that meet or exceed the level of quality, features and capabilities specified will be considered for installation. The Employer's Consultant reserves the right to govern over and proclaim whether proposed substitutions are equal to the specifications.

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- .3 The Employer Consultant may approve or disapprove the request for substitution or alteration. The Contractor shall not procure any substitute material until the Employer's Consultant's representative has approved the request for substitution. Any procurement or work performed prior to approval is at the risk of the Contractor.
 - .4 Additional costs after approval resulting from the use of an approved substitution shall be borne by the Contractor without additional expense to the Employer. Such additional costs shall include necessary modifications and alterations to structural equipment, raceways and furnishings of all additional materials required to affect the substitution.
 - .5 Contractor shall submit separate pricing for recommended spares package, which lists each recommended component and a description of its function.
- .10 Subletting:
- .1 Refer to Contract Documents for procedures.
- .11 The Contractor shall coordinate with other system vendors, as identified elsewhere in this document, where appropriate, to facilitate equipment installation, scheduling, protection of equipment, and access to the project site in order to provide the Employer a complete project in a timely manner.

1.8 Delivery, Storage, And Handling

- .1 Deliver and store materials in manufacturer's original packaging labeled to show name, brand, type, and grade. Store materials in protected dry location off ground in accordance with manufacturer's instructions. Do not open packaging nor remove labels until time for installation.
- .2 Equipment damaged prior to system acceptance shall be replaced at no cost to the Employer.

1.9 Project / Site Conditions

- .1 Verify all project site conditions applicable to the Work of this Section. Notify the Consultant in writing of any discrepancies, conflicts, or omissions prior to tender opening. Otherwise, correct these at no additional cost to the Consultant or Owner.
- .2 Continue to monitor the project site. If conditions develop requiring a need to vary from the Specifications or Drawings, notify the Consultant immediately in writing. Make recommendations, submit drawings showing how the Work may be installed, and on approval, proceed with the necessary changes without additional cost to the Owner.

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1.10 Warranty

- .1 Warranty shall be 1 year from the date of provisional handover of all the works.
- .2 Warranty shall include all parts, labor, and the service technician's travel and living expenses for the entire 1-year period.
- .3 Contractor shall warrant that the Work shall be free of defects in material and workmanship for a period of two years from the date of Taking-over. Contractor shall promptly and at its own cost and expense correct Work that is rejected by Engineer or Work that fails to conform to the requirements of the Specification.
- .4 Contractor shall assign to Engineer all manufacturers' warranties relating to any of the equipment and materials, specifically the respective manufacturers' extended warranties. Contractor shall deliver to Engineer copies of all such warranties.
- .5 Contractor shall warrant that it has obtained all applicable licenses for Employer to use the Materials and has paid all required royalties for use of the system for its expected useful life.
- .6 Software License
 - .1 Required software licenses shall be identified and supplied by the Contractor. Licenses shall be "Site Licenses" which shall cover all equipment installed now or in the future.
 - .2 All software licenses and warranties shall be registered in the name of the Employer. Required software licenses shall be identified and supplied by the Contractor. Licenses shall be "Site Licenses" which shall cover all equipment installed now or in the future.

1.11 Maintenance

- .1 Base: The Contractor shall provide maintenance and support of all hardware and software associated with this system for the first year. The maintenance services to be provided by the Contractor shall include preventive, routine, and emergency maintenance services as defined below under optional maintenance and support.

~~.2 Optional: The Contractor shall provide option pricing for maintenance and support for two (2) years following the warranty period. The option pricing shall be given as a guaranteed maximum annual cost. This service is to include parts, labor, licenses, software upgrades, and all other contractor costs required to keep the equipment operational. Pricing shall be provided for the following two levels of support:~~

- ~~.1 Twenty four (24) hour a day, seven (7) day a week telephone support plus eight (8) hour on-site emergency support~~
- ~~.2 Twenty four (24) hour a day, seven (7) day a week telephone support plus two (2) hour on-site emergency support~~

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- .3 Preventive and Routine Maintenance: Preventative and routine maintenance services shall be provided in accordance with the provisions of the maintenance manual the Contractor issues for each component. Preventative maintenance services shall include inspection, test, necessary adjustment, lubrication, parts cleaning, and software upgrades. Routine maintenance services shall include scheduled overhauls as recommended by the equipment and software manufacturer. The Contractor shall include an Employer technician in maintenance activities during the warranty period to provide on the job training for Employer personnel.
- .4 Emergency Failure: A system failure is considered an emergency if any the key components are inoperative to the extent the system cannot function in a normal manner. Emergency services shall include inspections and necessary tests to determine the causes of equipment or software malfunction or failure. The emergency services shall include: the furnishing and installation of components, parts or software changes required to replace malfunctioning system elements. The Contractor shall specify a maximum amount of time to get the system up and operational in the event of an emergency failure. This time period shall be subject to Employer approval.
- .5 Special Equipment: The Contractor shall supply a list of special tools, test equipment, and outside inventory required for this project. The Contractor may recommend specific items to facilitate long-term support of the system.
- .6 Support Personnel: Technicians performing installation and maintenance on the proposed system shall be manufacturer certified on all hardware/software applications.
- .7 Hardware Support: The Contractor shall supply hardware support directly or by a subcontractor approved by the Project Engineer. Support shall cover all equipment and systems referenced in this specification.
- .8 Response Escalation Plan: The Contractor shall submit a recommended response escalation plan that defines the level of severity of problem and the associated response time. The use of this response plan and its details will be negotiated with the Employer. Repairs are to be made as expeditiously as possible. If parts are immediately unavailable, the fastest means of shipment shall be used, including overnight-expedited shipping.
- .9 Maintenance Log: The Contractor shall maintain a bound Maintenance Log Book of all preventative maintenance and corrective/repair services performed during the warranty period and any extended support period. The Log shall be in an Employer approved format. The Log shall be available for inspection by the Employer at any time during the year that it covers. The Maintenance Log Book shall be turned over at the completion of maintenance contract. The Log shall be kept on a component-by-component (equipment number) basis, with separate sections or volumes, as appropriate, for each component. The Log shall itemize the history of preventative maintenance and corrective/repair activities, stating the character, duration, cause, cure of all malfunctions and the individual's name that completed the repair. The Log shall record all hardware updates.

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PART 2 - PRODUCTS**2.1 Loudspeakers**

- .1 Loudspeakers of the following types shall be utilized, as per the drawings. All loudspeakers shall meet the requirements of BS 5839 part 8 complete with ceramic terminal blocks and thermal links and EN54 Part 24. Steel fire domes shall be fitted to recessed ceiling types. Sensitivity is to be measured using a pink noise signal across a wide bandwidth (as per IEC 60268-5:2003); sensitivity figures measured at a single frequency shall not be acceptable. There shall be no restriction to connect any EN54 part 24 Certified speakers to any EN54 part 16 certified headend equipment; different lab certifications for headend and Loudspeakers shall be accepted.
- .2 6Watts,5" Public Address, Voice Alarm and BGM frameless ceiling speaker (Corridors/lobbies/ FOH)
 - .1 The ceiling loudspeakers shall be installed to achieve a uniform sound level as appropriate subject to CONSULTANT approval.
 - .2 6W Rated power
 - .3 100V Line operation
 - .4 8Ω Driver impedance
 - .5 The speaker shall give 90dBdB@1W/1m average sensitivity.
 - .6 6Watt transformer for 6/3/1.5 volt or voice coil/8 Ohm Direct)
 - .7 Frequency Response shall 64 –21000 Hz.
 - .8 SPL at 1W/1m, peak shall be 97dB.
 - .9 SPL Pmax/4m, peak shall be 92.7 dB
 - .10 The unit shall have 5"full range driver with frameless front grill.
 - .11 Dispersion -6dB, 500Hz h/v shall be 180°.
 - .12 Dispersion -6dB, 1KHz h/v 180° shall be 175°.
 - .13 Mounting type shall be Quick-mount clamp.
 - .14 EN54 Part 24 part 8 or UL Listed
 - .15 Speaker shall be of European or USA/Canada origin.
- .3 6watts Public Address, Voice Alarm and BGM Cabinet /Wall Mounted Speaker (Staircase and BOH)
 - .1 6W Rated power
 - .2 Tapped at 3 Watts
 - .3 6W, 3W, 1.5W, 0.75W, 0.25W Transformer tapping's

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- .4 100V Line operation
- .5 8Ω Driver impedance
- .6 180Hz – 13kHz Effective frequency range
- .7 90dB Sensitivity (1W/1m) 100Hz – 10kHz bandwidth
- .8 97dB Full power octave bandwidth
- .9 180O Dispersion 1kHz
- .10 70O Dispersion 2kHz
- .11 White RAL9010
- .12 ABS Material
- .13 Screw mounting
- .14 Speaker shall be of European or USA/Canada origin.

2.2 Audio – Source Equipment

- .1 Audio Server (AS) - Shall have 4 channel output. Shall have internal storage sufficient for around 70 CDs stored uncompressed as WAV files, or as many as 80,00 MP3 files (at 128kb/s bitrate). Shall support Playback formats: Uncompressed (44.1 kHz/16bit) Compressed: MP3 (128, 160, 192CBR, 192VBR and 320kb/s) and Recording formats: Uncompressed (44.1 kHz/16bit) Compressed: MP3 (128, 192VBR and 320kb/s). Shall have Frequency response: 20Hz - 20 kHz ±0.5dB typical, S/N ratio (@ 1 kHz): typically, 100dB, Dynamic range: better than 96dB. Shall have CD tray loader. Shall support to browse by individual track names, albums, artists, covers, playlists, genres, years, eras and presets. Shall be able to control with third party control system through RS232 port. Shall have an Ethernet port.

- .2 DIGITAL AUDIO PLAYER - MP3/ CD/AM/FM:

The Digital Audio Player shall be 19” rack mounted type where applicable. It shall be equipped with a full function remote control with discs’ key and power ON/OFF. It shall have independent Audio output and volume control for Music Player output and Radio output.

The unit shall have two independent backlit LCD screens. One for control, navigation in MP3 files and information on audio reproduction. The other screen shall shows information on the dial and selected pre-sets of the digital radio tuner.

The specification of the Audio Player shall be as follows: -

- Form: Rack Mount.
- Playing formats shall be CD /MP3/ AM/FM tuner.
- Dual audio source; music player and FM tuner
- CD, MP3 player and Bluetooth connectivity.
- Line output: 500mV/1k.

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- Channel crosstalk shall be 65dB.
- Dynamic range shall be 75dB.
- SNR shall be 85dB
- Frequency response: 20Hz to 20kHz
- Frequency range (FM) 87.5 MHz - 108 MHz
- Frequency range (AM) 522 Hz - 1620 kHz.
- FM sensitivity shall be $\leq 10\mu\text{A}$.
- AM sensitivity shall be $\leq 100\mu\text{A}$.
- Power supply shall be 230V - 50Hz.

2.3 Audio – Digital Signal Processors (DSP)

- .1 All audio input signals, and prerecorded messages shall be processed and routed in the digital domain. The DSP Audio processor unit shall monitor all the units and devices in the PAVA system. The following facilities shall be available within the routing equipment:
 - .1 Total Harmonic Distortion: $< 0.01\%$ at 1 kHz.
 - .2 Audio format: 48KHz/24-Bit
 - .3 Frequency response: within plus or minus $\pm 0.5\text{dB}$ from 20 to 20,000 Hz
 - .4 Minimum of 6 audio inputs per frame.
 - .5 Audio input sensitivity: -60/-40/-20/0dBu.
 - .6 Network method between the controllers shall be one of three:
 - .1 High-speed Digital Expansion Bus (In case of Single Location)
 - .2 Inbuilt Fiber Glass (2x SPF Slot) Cards inside the PAVA controller
 - .3 Dedicated Fiber optic connectivity using approved external EN54 Industrial switch. (the Switch shall be pre-approved as part of the EN54 Part 16 PAVA Headend equipment's test report. Testing report from third party lab shall be submitted before approval)
 - .7 Minimum of 6 audio outputs per frame and up to 24 audio outputs.
 - .8 Cascadable units are accepted
 - .9 Minimum of 6 x combined digital and analog inputs for fire detection interface per frame
 - .10 Minimum of four-band parametric equalizer for input audio and 10 band parametric for audio output.
 - .11 Inbuilt limiter, Automatic Gain Control, Compressor and limiter.

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- .12 Inbuilt Digital Message player- a minimum of 30 minutes with the capacity of adding extra minutes for non-emergency purposes.
 - .13 Inbuilt delay feature: 1-200ms (1dB steps).
 - .14 Hardware bypass Microphone ports.
 - .15 Internal timer.
 - .16 Integral LCD
 - .17 UL listed or LPCB or Vds or Kite Mark or Telefiction B.V
 - .18 EN54 part 16.
- .2 If the proposed EN54 DSP Controller consists of separate physical audio inputs module, separate audio outputs modules, separate message player and separate EN54 monitoring module, then each of such modules shall be duplicated for redundancy purposes as well the networking media.

2.4 EN54 Digital Power Amplifier

- .1 The system shall include high quality 100V or 70V Line amplification
- .2 All amplifiers shall be Class D type and shall be monitored for correct operation and correct gain settings, to ensure that the commissioned settings are maintained. Gain control shall normally be achieved via the routing equipment; however, each amplifier shall include a pre-set gain control on the rear panel. Any Analogue Amplifier (Class AB) should not be acceptable.
- .3 Each amplifier shall include a separate AC power supply system and DC standby feed to minimize the effect of any failure. The system shall be capable of indicating a failure of the DC supply to an amplifier (including the DC fuse) when the amplifier is powered from mains AC.
- .4 The Amplifier shall be equipped with RJ45 ports for reporting fault/health status to the Main Audio Controllers and Desktop Paging Microphones. The Fault Codes shall be displayed on the Integral LCD of the DSP Controller and Paging Microphone as below:
 - .1 Amplifier Frame Reset
 - .2 Amplifier Frame Networking (Communication)
 - .3 Amplifier Frame Power Supply
 - .4 Amplifier Card or Module Surveillance
 - .5 Amplifier Card or Module Short Circuit
 - .6 Amplifier Card or Module Open Circuit
 - .7 Amplifier Card or Module Earth
 - .8 Amplifier Card or Module Temperature

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- .5 Use of amplifier's general fault contacts as inputs to the PAVA controller shall not be accepted. Concept of monitoring the power Amplifier based on reading the 100-volt line audio feed as input to the DSP shall not be accepted. General Amplifier Error or General Speakers Line Error indicated on the PAVA Controller or Paging Microphone shall not be accepted.
- .6 Live demonstration of error codes generation shall be conducted prior to any final approval for the technical submittal.
- .7 The PAVA controller shall control the Amplifier Inputs and Outputs through direct data communication link.
- .8 Any power or control switches on the front side of the amplifier shall not be acceptable. All switches should be integrated on the rear side.
- .9 Amplifiers shall be Hot swap Modular Card Type Class-D Amplifier Unit. One 2U or 3 U Frame shall have minimum capacity of 200 Watts/ Amplifier channel. Any smaller size capacity shall not be accepted. Wall Mount Amplifier panels shall not be accepted.
- .10 Hot Swap shall allow the operator to plug in /plug out any Card in the Amplifier Frame without any wiring or screw termination and without switching off the power of the amplifier frame.
- .11 All audio inputs shall be 0dB Balanced type
- .12 Frequency response shall be from 20Hz – 20kHz
- .13 Total Harmonic Distortion shall be Less than 0.5%
- .14 Signal Efficiency shall be >80dB
- .15 The front panel of the unit shall have LED Indication: Power (green)/Signal (green)/ Fault (amber)
- .16 Battery backup for 24hours in case of power failure and 30minutes during alarm
- .17 The operating temperature shall be - 10 C to + 55 C. Any operating temperature less than + 55 C shall be rejected. A confirmation letter or test report from third party Lab confirming the temperature range shall be submitted for approval.
- .18 Each frame shall support a minimum of Five amplification Cards. The minimum total load for each amplifier frame shall be 1000 watts without backup.
- .19 Each amplifier frame shall incorporate EN54 or UL864 battery charger and external dedicated batteries for each frame. The battery shall feed the amplifier and one DSP Controller and Microphone in case of power failure. External EN54 charger for each frame is accepted as well.
- .20 Systems based on two batteries to feed the whole rack's component is not accepted. Maximum of (2000 Watts) amplification, audio controller and two paging microphones shall have its own charger and batteries.

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- .21 As an accepted alternative of Hot swap Amplifier Card (Clause C.10), the amplification headend shall be as below:
- .1 Each single amplifier channel shall be physically a separate unit (1U or 2U Size) serving one circuit (Class A wiring).
 - .2 The power output of each single amplifier shall be minimum of 200 Watts.
 - .3 Stand by single amplifier module shall be considered as separate physical unit to switch automatically any of the faulty duty Amplifier. the quantities of standby Amplifiers shall 1: 4.
 - .4 In case of failure of any duty amplifier, it shall not affect the operation and functionality of any other amplifier Modules. While replacing the faulty Amplifier Module/ unit, the power supply of the unit itself shall be off without switching off the power of the other amplifier module.
 - .5 Each single Amplifier unit shall have its own power distributed socket and separate power switch. The nominal power input shall be 230 VAC and input frequency 50/60 Hz,
- .22 Any deviation to point C.10 and i or point C.21 shall not accepted and shall be rejected.
- .23 IECEE(IEC 60950) certified.
- .24 LPCB or VDs or Kitemark or Telefiction.
- .25 Accepted Products
- .1 Biamp
 - .2 ASL
 - .3 Bosch
 - .4 Approved Equal

2.5 EN54 Power Supply and Charger Unit (in Case of Separate Unit)

- .1 The power supply should perform the following functions:
 - .1 Battery recharging
 - .2 Distributing battery current to the point of use in the event of an alarm
 - .3 Testing the battery grid
 - .4 Indicating operating states
 - .5 Providing a guaranteed 30 minutes endurance under alarm conditions, so long as the battery is sized adequately.
 - .6 EN54 or UL listed for emergency purpose.

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- .2 A standby supply shall be included with the system to ensure that should the mains AC supply fail; the system will continue to operate.
- .3 The support time shall be 24 hours in standby (quiescent) conditions plus a further 30 minutes use at full load.
- .4 Changeover to this supply shall be automatic and silent, and the batteries shall be charged when mains is present.
- .5 The power supply should comply with the following regulatory and standard compliance:
 - .1 EMI: Emission EN 50 081-1
 - .2 Immunity EN 50 130-4
 - .3 Safety: EN 60 950 class I, EE, EN
 - .4 Application Compliance: EN60849 or EN54 Part 16
- .6 Battery Calculation should be submitted for approval

2.6 EN54 Part 16 Desktop Emergency Paging Microphone

- .1 Paging microphones shall be of the moving coil type on adjustable goosenecks with uni-directional condenser characteristics. The microphones shall have a frequency response range of 150 - 15 KHz and a sensitivity +70 dB. The nominal impedance shall be 250 ohms with Dynamic Cardioid Polar Response.
- .2 The paging microphone shall be mounted on a table desk with capacitive touch display for selective paging of different zones, as agreed at site. Zone selectors icons shall activate a tone generator and produce a chime tone prior to announcements. The microphone shall be muted during the period of the chime tone.
- .3 This shall be supply with the following features:
 - .1 Output level : Minus 58 dB, minimum.
 - .2 Connection: Dual port of RJ45 (RS485 protocol) for direct redundancy with the
 - .3 audio controller. Live demonstration for the redundancy of dual connectivity shall be conducted prior to final approval of the technical submittal.
 - .4 RS485 communication protocol allowing the distance between controller and
 - .5 microphone to be 500 m without any external power supply.
 - .6 Key lock or password protection for security and non-tempering purpose.
 - .7 Mounting: Desk stand with press-to-talk switch or integral capacitive touch
 - .8 keypad.
 - .9 Integral LCD Display.
 - .10 Evacuation, power, and fault indication.

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- .11 Live, store and broadcast feature.
 - .12 Speech level indication
 - .13 Zone paging selection and volume control.
-
- .4 In the unlikely event of catastrophic processor/DSP failure within the routing equipment this microphone shall still be able to access all zones simultaneously
 - .5 Wall Mounted Emergency Paging and Control/monitor unit shall be considered at Fire Command Centre for the Entire Site

2.7 PAVA Control and Monitoring Graphics User Interface (GUI) PC

- .1 Public Address, Voice Alarm and BGM Touchscreen GUI shall be considered which shall provide both control and monitoring of Public Address and Voice Alarm system.
- .2 The Touchscreen shall be used as a graphic microphone display in conjunction with a separate microphone. The Touch screen GUI and Paging microphone shall operate together as a paging microphone, with full integration between the desk microphone and graphic display. Thus, the PA zones shall be selected for a broadcast either on the graphic display or using physical microphone buttons, and the PTT shall be Pressed to Talk either on the graphic display or on the microphone itself.
- .3 The Touch screen PC shall provide background music routing function, controlling a music feed which connected into the Touch screen analogue audio input.
- .4 The Touch screen PC Digital Voice Announcer functionality shall enable PA announcements to be made from recorded 'Digital Voice Announcer' (DVA) messages which are stored within the PC. As well as immediate broadcast functions, DVAs shall be scheduled to be automatically broadcast at intervals, and new DVA messages can be recorded by the user. Alternate chimes shall be used, and the customer's own chimes shall be loaded onto the unit as well.
 - .1 The 2D display graphics shall use a standard .png image file, and normally either just show PA 'zone select' buttons or show a customized site plan with the physical layout of the PA zones being shown on the screen. site plan image shall be shown the area representing each zone acts as a 'zone select' button, with zone selection and announcement status being shown by different colors.
- .5 The GUI shall be based on an All-In-One PC and touchscreen monitor, together with mouse and keyboard. The Touch screen GUI interface to the PAVA system shall be via a RJ45 Ethernet port. It shall be connected to an IP network, across which the PA audio is routed using Voice over IP technology. Fault and status reporting shall be provided for the PA system.
- .6 Monitoring and System Logs shall be as follow:
 - .1 PA System Status and Fault Monitoring
 - .2 Alarm List, including standard alarm priorities and descriptions

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- .3 Event Log, showing all alarms and status changes
- .4 Broadcast log display and archive, including broadcast time, broadcast source and destination(s), plus live or recorded message flag, and with all message file names logged
- .5 PA System equipment status tree
- .7 Touch screen GUI shall have the minimum following specification:
 - .1 Connection to IP Network shall be 100BASE-T Ethernet
 - .2 Audio shall be VOIP Audio.
 - .3 Default Maximum Microphone Broadcast Length shall be 60s.
 - .4 Default DVA Maximum Message Length shall be 60s
 - .5 Pre-Recorded DVA Message Format (Preferred) File Format shall be WAV
 - .6 DVA Sample Rate shall be 48 kHz Bit Depth 16 bits
 - .7 Graphic Zone Image File Format shall be PNG and Image Size shall be 960 pixels wide/ 640 pixels' high
 - .8 Touchscreen PC LCD shall be 23-inch 1920*1080 widescreen Touchscreen TFT display
 - .9 Touchscreen PC LCD power supply shall be 100-240 V AC

2.8 Wire and Cable

- .1 Cables shall be of the gauge required depending upon the cable run length as recommended by the manufacturer.
- .2 Speaker Cable shall be fire rated following the relevant local authorities' regulation and following standards:
 - .1 BS6387: Specification for performance requirements for cables required to maintain circuit integrity under fire conditions.
 - .2 IEC60331-1 Tests for electric cables under fire conditions part 1
 - .3 IEC60332-3 Tests on Electric Cables under Fire conditions part 3
- .3 Microphone Cable shall be CAT6A and Stranded fire rated
- .4 Networking Cable between the Racks shall be Fiber optic Multimode (4 Core and shall be Fire Rated).

2.9 Terminations

- .1 Contractor shall submit separate pricing for recommended spares package, which lists each recommended component and a description of its function.
- .2 Low-level (microphone, line level, control system) signal wiring.

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- .3 High-level (speaker, DC power) signal wiring.
- .4 Cable Markers. Permanent labels corresponding to the Contract Drawings affixed to all cables.

2.10 Spare Parts

- .1 Contractor shall submit separate pricing for recommended spares package, which lists each recommended component and a description of its function.

PART 3 - EXECUTION**3.1 Fabrication**

- .1 Complete all custom fabrication work off site.
- .2 Verify the depth of any rack, cabinet or enclosure prior to assembly to ensure that mounted equipment will fit completely inside with the door or cover closed (if applicable).
- .3 Install all rack-mounted equipment and test the systems before delivery of equipment racks to the project site.

3.2 Source Quality Control

- .1 All products shall be from an ISO 9001 registered Manufacturer and shall be UL listed.
- .2 Where applicable, all materials and equipment shall bear the label and listing of Underwriters Laboratory and or CE. Application and installation of all equipment and materials shall be in accordance with such labeling and listing.

3.3 Examination

- .1 Examine the areas to receive the Work and the conditions under which the Work would be performed. Identify conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

3.4 Installation

- .1 Install components in accordance with contract drawings, manufacturer's instructions and approved submittal data.
- .2 The PAVA system shall be installed using a fire-resistant LSOH silicon rubber insulated cable with PVC/Aluminum composite sheath. The outer sheath shall be colored red to distinguish it from another cabling. The cables shall not be painted over.
- .3 Conductor sizes shall not be less than 2.5 sq mm but shall be sized by the specialist fire alarm contractor to ensure correct operation throughout the installation.
- .4 Installations shall fully comply with the requirements of NFPA 70, NFPA 72, BS 5839-part 8 and NECA 1 and shall be in accordance with the manufacturer's recommendations.

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- .5 The manufacturer's recommended components shall be used for all supports, connections and terminations. Special attention is drawing to the provision of the manufacturer supplied PVC ferules which form part of the cable system.
- .6 The installation and connection of the above cables shall be in accordance with the manufacturer's recommendations and the contractor shall, if requested by the consultant, furnish proof of his employees' ability to carry out the work to these requirements.
- .7 Labeling
 - .1 Label product in a logical, legible, and permanent manner corresponding to the Contract Drawings using wording, format, style, color, and arrangement of text approved by the Consultant.
 - .2 Provide engraved plastic labels similar to Lamacoid, squarely and permanently attached, to label patch panels, barrier strips, terminals and similar devices as well as the front and rear of all equipment within racks.
 - .3 Label all permanent wiring on both ends with approved permanent clip on type or sleeve type markers. Wrap around adhesive labels will not be accepted unless completely covered with clear heat shrink tubing.
- .8 Engraving
 - .1 Refer to drawings for plate engraving and construction details.
- .9 Equipment Racks and Equipment Furniture
 - .1 All equipment with equipment racks and equipment furniture shall follow manufacturer's recommendations.
 - .2 Provide adequate ventilation or fans to maintain a maximum rack temperature of 90 degrees Fahrenheit.
 - .3 Floor racks located in equipment rooms to be mounted on a platform minimum of 2 inches high.
 - .4 Provide unused panel space with blank or vent panels, painted to match housing.
 - .5 Provide rear support for housing mounted equipment greater than 350mm deep.
 - .6 Locate user equipment at convenient height.
 - .7 Provide locking doors
 - .8 From the rear, Install AC power and ground cabling on the left; audio and video cabling on the right.
 - .9 Provide service lights with the rack for maintenance.
 - .10 Do not mount panels or equipment on the rear housing rails.
- .10 Grounding and Shielding
 - .1 Earthing and Bonding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

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- .2 Mount equipment racks in a manner which provides electrical isolation from the building structure and electrical raceways. Use flexible conduits and PVC fittings to provide insulated connections between equipment racks and the building electrical raceways.
 - .3 Ground the chassis of all rack mounted components in accordance with the manufacturer's instructions and verify a D.C. resistance between each chassis and the rack ground bus bar.
- .11 Cutting and Patching
- .1 The Contractor shall be responsible for all cutting, fitting, and patching, required to complete the Work including, but not limited to:
 - .1 Work required making several parts fit together properly.
 - .2 Removal and replacement of defective Work
 - .3 Removal and replacement of Work not conforming to the requirements of the Contract Documents
 - .4 Removal of samples of installed Work as specified for testing.
 - .5 Routine penetrations of non-structural surfaces to permit installation of new construction elements
 - .6 Cutting and patching associated with new construction, the installation of ill-timed work and corrective work.
 - .2 Provide adequate supervision for all cutting operations and maintain structural integrity at all penetrations. Carefully perform all cutting to the existing surfaces encountered during the course of the Work of this project to the extent necessary and required to permit the installation of new Work and to remove existing Work in place.
 - .3 Close all abandoned penetrations, new and old, whether visible or concealed, in and adjacent to work being performed as a part of the Work of this Contract when such penetrations are revealed by demolition procedures specified herein.
 - .4 Use matching materials and finishes. Obtain Consultant's prior approval before installing materials or finishes, which substantially deviate from existing material, color or texture. Comply with the other specified requirements.
 - .5 Prior to cutting and patching in rated construction, consult with relevant engineer.
 - .6 Upon completion of cutting and patching in rated construction, repair wall, ceiling, or floor assembly as necessary to maintain the required fire rating.
 - .7 Any penetration through fire rated walls (including those in sleeves) will be resealed with an Underwriter Laboratories (UL) approved sealant. Confirm with local Authorities Having Jurisdiction for requirements.

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.12 Wiring Practices

- .1 All wiring shall be installed in accordance with manufacturer's recommendations and related InfoComm and ISO/IEC standards.
- .2 Exercise care in wiring to avoid damaging the cables and equipment. Use grommets around cut outs and knock outs where conduit or chase nipples are not installed.
- .3 Do not splice cables of any signal category under any circumstances without prior approval of the Consultant.
- .4 All cables terminated in a connection plate mounted in an enclosure shall be dressed to allow removal from the enclosure and sufficient cable length for service or re-termination. Plate shall set on floor or freely swing clear.
- .5 Group all wiring into the following classifications by power level or signal type:
 - .1 Microphone Level: less than 20 dBm.
 - .2 Line Level Audio and DC Control Circuits: 20 dBm to +30 dBm.
 - .3 Speaker Level: greater than +30 dBm.
 - .4 AC Power Circuits
- .6 Maintain a minimum six-inch separation between wiring of different level classifications wherever possible. Otherwise, cross them perpendicular to each other. Where wiring of different level classifications share a common enclosure or junction box, provide metallic isolation barriers to completely electrically separate wiring groups.
- .7 Neatly harness wires together within racks by power level classification using horizontal and vertical wiring supports as required. Rigidly support all wires within twelve inches of connection points.
- .8 Observe consistent polarity throughout the systems:
- .9 Cut off unused wire ends approximately one-half inch ($\frac{1}{2}$ ") past the wire jacket. Fold them back over the jacket, and secure in place with heat shrink tubing.
- .10 All cable installed under this specification which is to be terminated by others for "future" or Employer Furnished Equipment (EFE) in racks, shall be provided with ten (10) feet of slack when dressed to the location of future or EFE equipment. All cable installed under this specification, which is to be terminated by others, shall be provided with twenty (20) feet of slack when ending in a rack enclosure. All cable provided under this specification, to be terminated by others, shall be provided with fifty (50) feet of slack when terminating in an equipment room without a clear point of demarcation, or in a group of racks where the destination is not known.
- .11 Cable Installation in Conduit and Duct Banks
 - .1 Pull mandrel one size smaller than the conduit, through entire length of all underground conduits.

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- .2 Cable pulling lubrication shall be utilized when pulling cable.
- .3 Pulling grips suitable for use with fiber cables shall be applied to the ends of the cable. Consult cable manufacturer to determine appropriate pulling grip and method of attachment. Breakaway or fuse links shall be used at the pulling grip. Insure that the correct "fuse pin" is installed in the fuse link.
- .4 Cable caps (heat-shrinking type) shall be used to seal the ends of the cable to protect the cable ends prior to terminating.
- .5 The bend radius for all cables shall conform to manufacturer's specifications.

3.5 Field Quality Control

- .1 Maintain a competent supervisor and supporting technical personnel, acceptable to the Employer during the entire installation. Change of supervisor during the project shall not be acceptable without prior written approval from the Employer.
- .2 Before connecting any equipment to electrical power outlets, measure and record the A.C. voltages between hot, neutral, and ground and verify correct outlet polarity. Verify test and document correct and safe function of isolated ground power systems.
- .3 Determine the best sequence of energizing systems to minimize the risk of damage.
- .4 After successfully energizing the systems, make preliminary adjustments and document the settings of all controls, parameters of corrective networks, voltages at key interconnection points, gains and losses as applicable. Replicate the gain structure tests performed at the shop and document the absence of any waveform distortion, interference signals, or oscillations.
- .5 The Contractor shall develop and execute an onsite acceptance-testing program.
- .6 The plan shall address all requirements identified in this specification and test all Contractor supplied cabling and hardware components. The plan shall follow accepted industry testing practices and have a method of independent verification.
- .7 Any specified item that does not satisfy the requirements of this specification shall be replaced, upgraded, or added by the Contractor as necessary to correct the noted deficiencies. After correction of a noted deficiency, re-testing shall be performed to verify the effectiveness of the corrective action.
- .8 Field Inspection of Connections: Perform 100% visual inspection of the Work. Examine the size, quality and placement of each connection to verify installation in accordance with Contract Documents and executed shop drawings.
- .9 Manufacturer's Field Service: At the start of the installation, periodically as the Work progresses, and after completion, furnish the services of the manufacturer's technical representative at the job site as necessary to advise on every phase of the Work. As a minimum, furnish full-time attendance during the first three work days, at least once every week thereafter, and furnish technical assistance to the Installer as may be required.

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- .10 It shall be the responsibility of the Contractor to perform the necessary adjustments and balancing of all signals, gain, and other level controls to ensure proper system operation. The system shall be physically inspected by the Employer to assure that all equipment is installed in a neat and workmanlike manner as called for by the plans and specifications.
- .11 Verify the performance parameters of the individual systems following established professional procedures, in addition to those specified herein. Document all acceptance testing, calibration and correction procedures described herein, to include the following information:
 - .1 Performance date of the given procedure.
 - .2 Condition of performance of procedure.
 - .3 Type of procedure, and description.
 - .4 Parameters measured and their values, including values measured prior to calibration or correction, as applicable.
 - .5 Parameters associated with calibration or corrective networks, components, or devices.
 - .6 The names of personnel conducting the procedure.
 - .7 The equipment used to conduct the procedure
- .12 Audio Testing
 - .1 Refer to InfoComm Standards for audio testing procedures.

3.6 Test Equipment

- .1 Furnish the following equipment. Equipment to be available for the entire test period through final system testing.
 - .1 All Source Code related to the project on CD-ROM or portable media.
 - .2 Sound Level Meter: ANSI S1.4-1971 Type SEA with digital display.
 - .3 Multimeter: Measurement range, DC to 20 kHz, 100 mV to 300V, 10 milliamp to 10 A.
 - .4 Miscellaneous adapters including Stereo to Mono, 2 RCA to mini Stereo, 2 RCA to mono, S-VHA to 2 BNC, VGA to 5 BNC etc.
 - .5 Ladders and scaffolding necessary to inspect all speakers.

3.7 Training

- .1 The Contractor shall allow for training the Clients operational and maintenance staff. Training proposals, including session objective, presentation formats, time allowances and numbers of sessions, shall be included within the Tender.

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- .2 Training shall be given by suitably qualified members of the Contractors staff and/or the system manufacturer, who is familiar with both design and the implementation of the system. The Contractors specialist design engineers shall be involved with the training.
- .3 Training shall be completed before system acceptance by the Consultant. Training shall not commence until the system manuals have been provided.

3.8 Inspection

- .1 Provide a statement of completion certifying that the system is installed and is ready for acceptance testing and equalization to the Consultant.
- .2 Schedule a time for the Consultant to perform system acceptance testing and equalization with at least 14 days advance notice.
- .3 Furnish a technician who is familiar with the system to assist the Consultant during the acceptance testing and equalization for the duration of time it takes to complete the adjustments (regular time or overtime as required). A minimum of 24 hours, as required to complete the adjustments.
- .4 Each cable shall be inspected for proper termination.
- .5 System flatness test shall employ an approved sweep transmitter receiver pair. Sweep measurements shall be taken at the termination of every cable termination in the system. Where possible, record sweep results by photographic means.
- .6 Record final settings on all equipment and submit with contract closeout documents.
- .7 Upon completion of initial tests and adjustments, submit written report of tests to the Employer along with all documents, diagrams, and record drawings required herein.
- .8 If the system does not meet criteria or if additional trips to the job site for testing or equalization are required, the Contractor shall reimburse the employer for all expenses and professional time encountered by the Consultant.

3.9 Adjusting

- .1 Upon completion of the Work repair surfaces that have been permanently stained, marred, or otherwise damaged. Replace Work which is damaged or cannot be adequately cleaned as directed.
- .2 Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of Contractor's deficient work/defective equipment.
- .3 The Employer reserves the right to direct changes to the system software and programming for a period of three months after final acceptance including audio DSPs, programmable video control equipment, control systems and touch panels, etc. Such changes shall be made without additional cost to the Employer.

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3.10 Cleaning

- .1 Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed unless designated for storage.
- .2 Clean all areas around system equipment and be sure that the inside of each equipment rack is free of wire stripping and other debris.

3.11 Protection

- .1 Protect the Work during the construction period so that it will be without any indication of use or damage at the time of acceptance.

END OF SECTION

Clock Systems

PART 1 - GENERAL**1.1 General Requirements**

- .1 Section 26 01 00 – Electrical General Requirements.
- .2 Section 26 00 00 – Basic Materials and Methods.

1.2 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 clock systems and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 Delivery, Storage and Handling

- .1 Deliver, store and handle materials in accordance 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 dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect clock systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS**2.1 Clock System**

- .2 GE clocks and accessories are high-performance timekeeping devices that offer a wide range of options and features. In addition to standalone battery-powered models, GE offers reliable clocks, controllers, and accessories compatible with centrally-controlled and self-correcting systems. Several of these work in combination with StarCall, StarCare, and MCS350 systems to provide a total timekeeping and communications solution.
- .3 Accessories:
 - .1 24A716 Battery Operated Clock
 - .2 250750 Dual-faced Digital Clock and Speaker Housing
 - .3 24DW750, 24DC750 Double Faced Digital Secondary Clock
 - .4 25F750 Digital Clock/speaker Housing

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- .5 24SS Series Synchronous Secondary Analog Clock
- .6 24CC10 Clock Controller
- .7 110-3902 Dual Four-inch Digital Clock Housing
- .8 24D20A Two-Inch Digital Secondary Clock
- .9 24D40A Four-inch Digital Secondary Clock
- .10 24DS250 Digital Clock/speaker
- .11 24SC12R Analog Secondary Clock
- .12 9AI 900 Elapsed Timer Start Button
- .13 110-3693 AC Clock Power Supply
- .14 110-3836A Digital Clock Sync Module

2.2 24CC10 Clock Controller

- .1 User-friendly front panel controls
 - .1 Controls GE two-inch or four-inch digital clocks
 - .2 Operating modes: 12 or 24-hour clock; count down timer; elapsed timer; score board; code blue elapsed timer
 - .3 Operates independently or as slave to master clock
 - .4 Timer display settings: hours/minutes; minutes/seconds
 - .5 Operates from 15Vdc or 24Vac
 - .6 Mounts in standard three or four-gang backbox 12-Hour dial face numbers
- .2 The GE Model 24CC10 Clock Controller is a compact, microprocessor-controlled unit that enables a GE 24D20 Two-Inch Digital Secondary Clock or 24D40A Four-Inch Digital Secondary Clock to be used for count up timing, count down timing, score keeping and code blue timing. The digital clock serves as the time indicator and display for the clock controller in the room. The digital clock is mounted for optimum visibility, while the clock controller is mounted in a convenient location that allows access to its controls.
- .3 The Model 24CC10 Clock Controller is designed for ease of use, with logical button groupings, intuitive labeling, and LED function guidance. When a particular operating mode is selected, related LEDs illuminate to indicate the commands available in that mode. A lock out feature allows the front panel controls to be disabled, preventing unauthorized use. The 24CC10 and its associated digital clock can operate as a stand-alone clock/timer or as a secondary clock under the corrective control of a GE Model 24A715 or 24A715M Master Time/Program Clock. The 24CC10 can also operate under the corrective control of a StarCall®, StarCare™ or MCS350 master clock. The 24CC10 is powered by a separate 10 to 24Vac or 10 to 15Vdc power source. The 24CC10 has five operating modes:

Clock Systems

- .4 Clock Mode displays the time on the GE digital clock in 12- or 24- hour format. In clock mode, the clock controller operates under the control of a master clock. In the absence of a master clock, the clock controller can operate in stand-alone mode, governing the time for its associated GE digital clock. Stand-alone mode does not provide battery backup for the clock display, therefore GE recommends that a master clock be used.
- .5 Count Down Timer Mode counts down to zero from a user-selected start time. The timer can count down by minutes and hours or by seconds and minutes. It can also be set to run silent, to beep when the timer runs down to zero, to chirp once per minute and beep at zero, or to chirp once per minute and once per second and beep at zero. During the count down sequence the timer can be stopped, restarted, and reset to its original target value.
- .6 Count Up Timer Mode measures the duration of an event. The timer can count up by hours and minutes or by minutes and seconds. It can also be set to run silent, to chirp once per minute, or to chirp once per minute and once per second. During the count up sequence the timer can be stopped, restarted, and reset to the initial timer value.
- .7 Score Board Mode uses the digital clock as a simple score board. The two left digits of the clock display the score of team 1 and the two right digits display the score of team 2.
- .8 Code Blue Timer Mode shows the elapsed time from when a code blue call is placed to when the STOP button is pressed on the clock controller. The code blue timer overrides anything currently displayed on the digital clock. This mode requires a contact closure from a separate device that initiates code blue calls.
- .9 Specifications:
 - .1 Operating Voltage: 24Vac nominal—recommended (10Vac min. to 30Vac max.)
—or—
15Vdc nominal (10Vdc min. to 30Vdc max.)
 - .2 Current Consumption: 91mA @ 10Vac, 50mA @ 24Vac
—or—
110mA @ 10Vdc, 75mA @ 15Vdc
 - .3 Terminations: Two pigtail connectors with 8 leads each (provided) One pigtail connector with 2 leads (for code blue; provided)
 - .4 Operating Temperature: 32°–90° F (0°–32° C)
 - .5 Dimensions: 4-1/8 in (10.5 cm) high x 8 in (20.3 cm) wide x 1-1/2 in (3.8 cm) deep
 - .6 Weight: Approximately 9 ounces (252 g)
 - .7 Mounting: Flush mounts into RACO 3 or 4-gang backbox, 2.5 in (6.4 cm) deep

Clock Systems

- .8 Finish: Bezel—textured gray ABS
Panel—textured gray polycarbonate
- .9 110-3902 Dual Four-inch Digital Clock Housing
 - .1 Dimensions: 7 in (17.8 cm) high, 19 in (48.3 cm) wide, 4-1/2 in (11.43 cm) deep
 - .2 Weight: 4.4 lbs (2 kg), less backbox and clocks
 - .3 Mounting: Wall-mounted using two-gang masonry box Ceiling-mounted using conduit extensions
 - .4 Finish: Charcoal gray
- .10 Specifications:
 - .1 Diameter: Face – 12 in (30.5 cm) Housing -13-3/8 in (34 cm)
 - .2 Depth: 2-3/4 in (7 cm)
 - .3 Shape: round
 - .4 Face: Arabic numerals, 12-hour format (24-hour available (-24H))
 - .5 Colour: Black housing (white available (-W))
 - .6 Shipping Weight: 3lb (1.4 kg)

2.3 24D40A Four-Inch Digital Secondary Clock

- .1 Highly visible four-inch LED
- .2 24Vac operation
- .3 Selectable LED display intensity
- .4 12- or 24-hour display
- .5 High efficiency
- .6 Can replace GE model 24D20 and 24F750A clocks for easy upgrades
- .7 ESD-hardened
- .8 The GE Model 24D40A Four-Inch Digital Secondary Clock provides a highly visible time display. It can be operated in either 12- or 24-hour format, and at either Bright or Normal intensity levels. Each minute the time display on the secondary clock updates to the master clock time. This ensures that all clocks in the system are in exact synchronization, and that every clock in the system is as accurate as the master clock. See the Associated Equipment list for the appropriate master clocks.
- .9 Installation of the Model 24D40A clock offers the following options:
 - For new installations, the 24D40A can be mounted into either a standard 4-gang masonry backbox or an 8A425 Surface-Mount Backbox, and can be operated from a 24Vac power supply.

Clock Systems

- For upgrade installations, the 24D40A can directly replace a Model 24D20 Two-Inch Digital Clock. Both units fit into a standard 4-gang backbox and share the same pigtail connector. (Check power supply reserve capacity before upgrading.)
 - In existing installations, the 24D40A clock can directly replace the GE Model 24F750A Digital Clock. The 24D40A fits into the same six-gang backbox and operates from the existing 15Vdc power supply. The pigtail connector of the existing installation can be directly applied to the new 24D40A installation without rewiring. (Check power supply reserve capacity before upgrading.)
- .10 Compliance with FCC Part 15 Class A emissions rules has been verified. As a result, the Model 24D40A clock meets the requirements for installation in educational, institutional, and commercial sites. The installed clock is ESD-hardened to IEC 801-2 Standards.
- .11 Engineering Specification
- .1 The Four-Inch Digital Secondary Clock shall be GE Model 24D40A or an approved equal. The digital clock shall provide an even-intensity, long-life time display in selectable 12- or 24-hour format. Each minute, the secondary clock shall receive a time display update from the master clock.
 - .2 The four-inch digital secondary clock shall fit into a standard four or six-gang backbox and shall offer adequate backbox clearance to reduce the possibility of shorts. The clock shall operate from either a 24Vac or 15Vdc power supply. The clock shall offer two display modes, either Normal or Bright intensity. The Model 24D40A clock shall include pigtail plug-in lead connectors.
 - .3 The clock shall comply with the FCC Part 15 Class A emissions rules, and shall meet requirements for installation in educational, institutional, and commercial sites. The installed clock shall also be ESD-hardened to the IEC 801-2 Standard.
- .12 Mounting: Wall-mounted using two-gang masonry box Ceiling-mounted using conduit extensions
- .13 Finish: Charcoal gray
- .14 Specifications:
- .1 Mounting: New Installations flush mount: RACO #693, 4-gang masonry backbox, 2-1/2 in (6.4 cm) deep, or RACO #698, 3-1/2 in (8.9 cm) deep, or approved equal Retrofit Installations (surface mount): GE 8A425, Four Inch Digital Clock Surface-Mount Backbox, 1-1/2 in (3.8 cm) deep, or approved equal
Upgrade Installations (to replace 24F750A clocks): RACO #960, 6-gang masonry backbox, 3-1/2 in deep (8.9 cm), or approved equal
 - .2 Power Requirements:
24Vac (+/- 5Vac) NOT TO EXCEED 30Vac
350mA in Bright display mode @ 24Vac
250mA in Normal display mode @ 24Vac

Clock Systems

For replacement of 24F750A: (see Note below) 15Vdc (+ 0/-2Vdc)

350mA in Bright display mode @ 15Vdc

250mA in Normal display mode @ 15Vdc

Note: When replacing 24F750A clocks, the pigtail plug from the previous clock can be directly connected to the 24D40A without rewiring. The rated current consumption of the 24F750A is 300mA, allowing direct replacement at the Normal intensity setting. If the Bright setting of the 24D40A is to be used, the existing loading on the power supply must be measured to see if there is sufficient supply capacity.

- .3 Viewing Distance: 160 ft (48.8 m) in the Bright intensity mode with normal lighting
150 ft (45.7 m) in the Normal intensity mode with normal lighting
- .4 Display Size: 4 in (10.2 cm) high by 10 in (25.4 cm) wide
- .5 Electrostatic Discharge: Installed 24D40A is ESD-hardened to IEC 801-2 requirements (+/- 8kV direct, +/- 15kV air discharge)
- .6 Terminations Pigtail leads color-coded to match GE Clock Cables 176-299 and 176-499
- .7 Lens: Anti-glare Acrylic
- .8 Dimensions: 5.8 in (14.7 cm) high by 19.0 in (48.3 cm) wide by 2.5 in (6.4 cm) deep
- .9 Weight: 2.5 lbs (1.1 kg) (without packaging)
- .10 Bezel: Charcoal gray ABS plastic, 5.8 in (14.7 cm) high by 19.0 in (48.3 cm) wide by 0.94 in (2.4 cm) deep
- .11 176-299 and 176-499: GE Clock Cable, 14-gauge, five-circuit, color-coded with designations on the jacket. Model 176-499 is a plenum rated version of Model 176-299.
- .12 8A425: Surface Mount Clock Backbox, 19 in (48.3 cm) long by 7 in (17.8 cm) high by 1.5 in (3.8 cm) deep, charcoal gray enamel finish. Low profile box allows the 24D40A to be mounted on an existing wall surface.
- .13 110-3693: AC Clock Power Supply, 5 amps (rms), mounts in a 145-184 Power Supply Backbox with either a 110-2190 flush-mount door or a 110-2191 surface-mount door (order separately according to your application's requirements). Three power supplies maximum per backbox.
- .14 110-3902: Four-inch Digital Clock Dual Enclosure, Wall or Ceiling Mount

Clock Systems

- .15 The Model 24D40A Four-Inch Digital Secondary Clock can be controlled by any of the following master clock products:

Note: Correction by MCS350 or selected StarCall may require use of Model 110-3836 Digital Clock Sync Module.

- .1 24A701: GE Master Clock (rack-mount)
- .2 24A702: GE Master Clock (wall-mount), flush with backbox
- .3 MCS350: GE Intercom System with Master Clock
- .4 SCR+: GE StarCall/StarCall Plus/StarCare Platform Integrated Communications Systems with the Model 437-00125 Master Clock Feature Package 1

2.4 9A1900 Elapsed Timer Start Button

- .1 Single switch operation
- .2 Stainless steel wallplate
- .3 Precious metal contacts
- .4 Works with model 24CC10 clock controller
- .5 The GE Model 9A1900 Elapsed Timer Start Button is used with the GE Model 24CC10 Clock Controller. When the PRESS TO START TIMER pushbutton is pressed, it provides a momentary contact closure that automatically starts the clock controller's "Count Up Timer" function, overriding all other active clock controller functions.
- .6 Specifications:
 - .1 Switch Type: SPDT momentary pushbutton (spring-action return)
 - .2 Designation: PRESS TO START TIMER
 - .3 Dimensions: 4-1/2 in (11.4 cm) high, 2-3/4 in (7 cm) wide, and 7/8 in (2.2 cm) deep
 - .4 Terminations: Pigtail Leads
 - .5 Net Weight 2 oz (56 grams)
 - .6 Finish: Satin-finished stainless steel
 - .7 Mounting: Standard flush-mounted single-gang backbox more than 2 in (5.1 cm) deep

2.5 110-3836A Digital Clock Sync Module

- .1 Provides interface between master and digital secondary clocks
- .2 Two high fan out outputs
- .3 Supports up to 500 model 24D20A two-inch or model 24D40A four-inch digital secondary clocks

Clock Systems

- .4 The Digital Clock Sync Module allows a master clock to increase its output drive capability in order to support multiple digital secondary clocks. The sync module supports up to 500 GE Model 24D20A two inch or Model 24D40A four-inch digital secondary clocks. Both high fan out outputs are required to drive the two control signals com-mon to each clock. The 110-3836A is only used for StarCall systems supplied with model 110-3521A CPC-E cards
- .5 Specifications:
 - .1 Power Requirements: +20 to +35Vdc 18mA, maximum
 - .2 Capacity: 500 GE Model 24D20A or 24D40A Digital Secondary Clocks
 - .3 Input Electrical Specifications: Maximum open circuit voltage = +15.5 Vdc
Maximum voltage to guarantee activation = +2 Vdc Minimum required sink capability of input contact = 1mA
 - .4 Output Electrical Specifications: Open drain output Maximum allowable peak open circuit voltage = 24V Sink capability = 2A DC ($V_{out} \leq 0.3V$)
 - .5 Input/output Response Conditions: Minimum input pulse low = 7 msec @ V_{in} low = 1.0V Minimum input pulse open circuit = 5 msec Output load = 2A DC @ $V_{out} < 0.3V$
 - .6 Output: Minimum output pulse ON time (sink) = 2 msec Minimum output pulse OFF time (open circuit) = 2 msec
 - .7 Termination Five pin and three pin terminal strips accepting stranded or solid wire, 26 to 16 AWG
 - .8 Dimensions 4.7 in (11.9 cm) long by 2.7 in (6.9 cm) wide by 1.0 in (2.5 cm) deep

2.6 110-3693 AC Clock Power Supply

- .1 Continuous duty operation
- .2 Easily accessible fuses
- .3 Screw terminal outputs
- .4 Includes correction coil relay
- .5 Outputs permit class 2 wiring
- .6 The AC Clock Power Supply provides a convenient 24Vac source for operating synchronous clocks and bells. The low voltage and cur-rent output of this power supply allows Class 2 wiring to be used. An onboard relay allows clock correction coils to be easily interfaced with GE master clocks. This supply mounts with the standard GE power supply backbox and doors.
- .7 110-3693 AC Clock Power Supply System:
 - .1 Rated Outputs: 24Vrms @ 5A unregulated total (two separate 2.5A outputs)
 - .2 Rated Input: 120Vac, 60 Hz, 1.4A

Clock Systems

- .3 Relay Input/Output: Coil rated 24Vdc @ 40mA Contacts rated 10A resistive with 240Vac or 30Vdc maximum
- .4 Net Weight: AC Clock Power Supply: 7 lb, 1 oz (3.4 kg) Flush Mount Door: 3 lb, 13 oz (1.7 kg) Surface Mount Door: 3 lb, 7 oz (1.6 kg) Backbox: 8 lb, 7 oz (3.8 kg)
- .8 Ordering Information:

.1	Model	Description
	24A716	Battery Operated Clock
	25D750	Dual-faced Digital Clock and Speaker Housing
	24DW750	Double Faced Digital Secondary Clock (wall mounted)
	24DC750	Double Faced Digital Secondary Clock (ceiling mounted)
	25F750	Digital Clock/speaker Housing
	145-192	Flush Backbox for 25F750 (110-3822)
		Overall dimensions: 13-3/4 in (35 cm) wide, 12-3/4 in (32.4 cm) high, 3-1/4 in (8.3 cm) deep
		Rear of box dimensions: 12-1/2 in (31.8 cm) wide, 12-3/4 in (32.4 cm) high
	110-3822	2 in Digital Clock/Speaker Baffle
	5A606	Speaker w/Transformer
	110-788	Surface or Dual Clock/Speaker Enclosure
.2	24SS Series Synchronous Secondary Analog Clock	
	24SS	Synchronous Secondary Analog Clock
	Wireguard	
	23 WG 12S	For 12 in Surface/Semiflush Clock 23 WG 15S
		For 15 in Surface/Semiflush Clock
	Associated Equipment	
	24A715, 24A715M	Master Clock or MCS350/StarCall/StarCare Master Clock (flush with backbox)
	8-SAM0576	Backboxes
	110-3693	Power Supply (Class II)
	145-184	Backbox, Surface or Flush Mounted, holds up to three Model 110-3693 Power Supplies
	110-2190	Flush Mount Door for Model 145-184 Backbox
	110-2191	Surface Mount Door for Model 145-184 Backbox

 Clock Systems

.3 24CC10 Clock Controller and Associated Equipment

24CC10	Clock Controller
24A715/ 24A715M	Master Time/Program Clock (optional)
24D20	Two-Inch Digital Secondary Clock
24D40A	Four-Inch Digital Secondary Clock
9A1900	Digital Clock Controller Remote Start Button
110-3693	24Vac Clock Power Supply (for use with additional digital secondary clocks)
17A437	24Vdc Clock Power Supply (80mA, plug-in, low power supply for use with one 24CC10)

.4 Dual Four-inch Digital Clock Housing and Associated Equipment

110-3902	Dual Four-inch Digital Clock Housing
24D40A	Four-inch Secondary Digital Clock
24D20A	Two-inch Secondary Digital Clock
RACO Model 696	Two-gang masonry box, 3-3/4 in (9.5 cm) high, 3-25/32 in (9.6 cm) wide, 3-1/2 in (9 cm) deep

.5 Digital Clock/Speaker and Associated Equipment

24DS250	Digital Clock/speaker
110-3822	Digital Clock Speaker Housing, identical to the Model 24DS250 except without the Model 5A606 speaker. This housing has the opening and capability for mounting a standard 8 in (20.3 cm) round speaker.
145-192	Backbox, flush mount. Overall dimensions: 13-3/4 in (35 cm) wide, 12-3/4 in (32.4 cm) high, 3-1/4 in (8.3 cm) deep. Rear of box dimensions: 12-1/2 in (31.8 cm) wide, 12-3/4 in (32.4 cm) high.
110-788	Surface Clock/Speaker Enclosure
5A606	Speaker W/Transformer

.6 9A900 Elapsed Timer Start Button

24CC10	Clock Controller
24D20A	Two-Inch Digital Secondary Clock
24D40A	Four-Inch Digital Secondary Clock

.7 Analog Secondary Clock and Associated Equipment

24SC12R-SPL	Analog Secondary Clock
-------------	------------------------

Clock Systems

24A715, 24A715M Master Program Clock

StarCall/StarCare Master Program Clock

110-3900 Mounting Plate (required if 110-3950 is not used)

110-3950 120Vac Adapter Kit

110-3693 Power Supply (Class II), 24Vac

110-2190 Flush Mount Door for Model 145-184 Backbox

110-2191 Surface Mount Door for Model 145-184 Backbox

145-184 Backbox, surface or flush mount (holds three Model 110-3693 Power Supplies)

.8 AC Clock Power Supply and Associated Equipment

110-3693 AC Clock Power Supply (1, 2, or 3 employed)

145-184 Backbox (Up to three power supplies can be mounted in a single backbox)

110-2190 Door (Flush Mount)

110-2191 Door (Surface Mount)

.9 Digital Clock Sync Module and Associated Equipment

110-3836A Digital Clock Sync Module

24D20A Two-Inch Digital Secondary Clock

24D40A Four-Inch Digital Secondary Clock

110-3693 24Vac Clock Power Supply Assembly

110-3521A CPC-E Central Processor Card (StarCall)

110-3542 Power Supply Module (StarCall)

PART 3 - EXECUTION

3.1 Installation

- .1 Locate master time clock centre and program control unit as indicated and connect to 120 V ac, 60 Hz power supply.
- .2 Run conductors as per Manufacturer's requirements from master time clock and program control output terminals to input terminals of digital clocks.
- .3 Provide all recessing material, labour, programming, testing, etc. for a fully operational central clock system.

Clock Systems

3.2 Site Tests

- .1 Perform tests as recommended to ensure proper operation of the clock systems.

3.3 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by clock systems installation.

END OF SECTION

Assisted Listening System

PART 1 - GENERAL

1.1 General

- .1 The General Conditions of CCDC-2 Division 1, form part of this section, and must be read in conjunction with the requirements of this section, and all related sections.
- .2 The work of this section, and related work specified in other sections shall comply with all requirements of Division 1 – General Requirements.
- .3 Conform to the conditions stated in the Contract Form and Supplementary Conditions.
- .4 This section of the Specification is an integral part of the Contract Documents and shall be read accordingly. This Section applies to and is a part of all Sections of Divisions 26.

1.2 Summary

- .1 Section Includes: Equipment for amplifying, transmitting and receiving sound signals for the hard of hearing, using FM signal technolog.

1.3 Submittals

- .1 General: Submit in accordance with Sections 26 01 00 and 26 05 00.
- .2 Product Data: For each specific piece of equipment.
- .3 Shop Drawings: Detail equipment assemblies and their connection, including interconnection cabling and antenna placement and orientation in the listening area.

1.4 Quality Assurance

- .1 Installer Qualifications: Experienced installer who is authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this Section.
- .2 Electrical Components, Devices, and Accessories: CSA or CUL and Industry Canada approved.

1.5 Warranty

- .1 Warrant system to be free of defects in operation for 5 years, including parts and labor. Warranty for cords, antennas, power supply, and accessories is 90 days.

Assisted Listening System

1.6 Scope

- .1 Provide one (1) complete set of Assistive Listening systems for Multi-Purpose Room.

PART 2 - PRODUCTS

2.1 Manufacturers

- .1 Acceptable Manufacturers:
 - .1 Williams Sound Corp., Eden Prairie, MN.
 - .2 Approved Equal

2.2 Acceptable Products

- .1 System: Personal PA FM Listening System, Model PPA 457.
- .2 Transmitter: Model PPA T45.
- .3 Receiver: Model PPA R37

2.3 Component Performance Criteria

- .1 Transmitter (Qty 1):
 - .1 Dimensions: 8.45 inch wide x 8.18 inch deep x 1.72 inch tall.
 - .2 Mounting: One EIA rack space high; ½ wide space.
 - .3 Power Input: 120 VAC, 60 Hz; 17 watts.
 - .4 Power Output: 24 VAC, 500 mA.
 - .5 Operating Frequencies:
 - .1 72.1 – 75.9 MHz, 10 wide band channels (selectable) 7 non-standard wideband channels (selectable).
 - .2 72.025-75.975 MHz, 77 narrowband channels (selectable)
 - .6 Frequency Accuracy: +/- .005% stability, 0-50 degrees C.
 - .7 Deviation:
 - .1 Wideband: +/- 75 kHz maximum.
 - .2 Narrowband: +/- 5 kHz maximum.
 - .8 RF Field Strength: Not exceeding 8 mV/m at 3 m.
 - .9 Nominal Range: 1000 feet (using ANT 005 coaxial antenna).
 - .10 Frequency Response: 22 – 16000 Hz, +1, -3 dB (adjustable)

Assisted Listening System

- .11 Signal To Noise Ratio: 74 dB transmitted.
 - .12 Audio Level Control: Push button audio level controls, adjustable from 0 to -50 dB.
 - .13 Audio Level Indicators: 10 LED array that reads +9 to -18 at 3 dB intervals.
 - .14 Phones Output: Mono signal, ¼ inch TRS stereo jack, 67 wM.
 - .15 Audio Input: Combination 3 pin XLR, ¼ inch TRS jack.
 - .16 Line Output: RCA jack, -10 dB V (.32 VRMS) output.
 - .17 LCD Menu Controls: Applications Preset (Music, Voice, Hearing Assistance), Bandwidth, Frequency, Audio Input Source (Microphone, Line, Simplex), High Pass Filter, Compressor Slope, Compressor Gain, RF Output Power.
- .2 Receiver (Qty 4):
- .1 Dimensions: 4.1 inch long x 2.85 inch wide x 1.2 inch high.
 - .2 Case: Gray polycarbonate impact resistant plastic.
 - .3 Weight: 4.5 oz.
 - .4 Battery Type: Two (2) AA alkaline non-rechargeable or NiMH rechargeable.
 - .5 Operating Frequency: Pre-tuned, field adjustable 72 Mhz – 76 MHz.
 - .6 Receiver Antenna: Integral with earphones.
 - .7 Input Connector: 3.5 mm mono phone jack.
 - .8 Earphone (standard): Earbud type with foam cushion.
 - .9 Battery Life: 100 hours (non-rechargeable)
 - .10 Frequency Response: 100 Hz– 15 kHz, +/-3 dB.
 - .11 Output: 35 mW, max at 15 ohms.
 - .12 Signal to Noise Ratio: 60dB at 100uV.
- .3 Accessories:
- .1 Single Mini Earbud Earphone: Model EAR 013 – Qty 4
 - .2 Deluxe Folding Headphones: Model HED 021 – Qty 4
 - .3 Neckloop (18 inch cord, 3.5 mm plug): Model NKL 001 – Qty 2
 - .4 Batteries (Rechargeable): BAT 026 – 2 per receiver
 - .5 12 Position Battery Charger: Model CHG 3512 – Qty 1
 - .6 Single Rack Mount Kit for PPA T37 Transmitter: Model RPK 005 – Qty 1

Assisted Listening System

PART 3 - EXECUTION

3.1 Installation

- .1 Provide the above mentioned products for each set of assistive listening system.
- .2 Install equipment to comply with manufacturer's recommendations.
- .3 Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.
- .4 Refer to Electrical Drawings for more information and comply accordingly.

3.2 Grounding

- .1 Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

3.3 Field Quality Control

- .1 Operational Test: Perform tests that confirm proper operation of system and proper coverage in area where equipment will be used.

3.4 Demonstration

- .1 Demonstration and Instruction of Owner's Personnel: Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the hearing assistance system.

3.5 Documentation

- .1 Provide as part of the owner's manual, all shop connection drawings of the system, final settings and manufacturer's equipment manuals.

END OF SECTION

Security Systems

PART 1 - GENERAL

1.1 General

- .1 General: Provide a complete security systems, CCTV, Intrusion alarm, Door Access, etc. Refer to the attachment appendix A (City of Brampton's Security Equipment Design Standards and Equipment Specifications for New Construction and Facility Refreshment Guidelines - total of 205 pages) and comply accordingly.

END OF SECTION



City of Brampton

Security Equipment Design Standards and Equipment Specifications for New Construction and Facility Refreshment

Version 10.0 – February, 2022

Document Owner: Supervisor, Security Systems
City of Brampton

Revision History

Version	Date	Revised by	Description of Revisions
1.0	June 2011	Martin Dambeau	Document Created
2.0	May 2012	Martin Dambeau	Introduction of Duress Event Stations (DES) and Key Control systems in Environmental Scenarios.
3.0	May 2014	Martin Dambeau	<ol style="list-style-type: none"> 1. Performance Design Criteria (CCTV and Access Control). 2. Inclusion of CCTV Equipment Specifications, Access Control Specifications, DES Specifications and Intrusion Detection Specifications. 3. Inclusion of Asset Tracking Labeling Standards 4. Security Systems LAN IP Range Reservations
3.1	Sept 2014	Martin Dambeau	Updated IP Camera Models
3.2	Nov 2014	Martin Dambeau	Inclusion of Fibre Media Converters
3.3	April 2015	Martin Dambeau	Update Axis IP Camera Model
3.4	May 2015	Martin Dambeau	Update RBH Technologies Controller Specs (UNC-500)
3.5	May 2016	Martin Dambeau	<ol style="list-style-type: none"> 1. Update to Axis and Panasonic IP Camera Model 2. Update RBH UNC-500 Model number
4.0	May 2019	Scott Bagley	<ol style="list-style-type: none"> 1. Updated equipment specifications to Division 28 Master format. 2. Updated equipment installation typicals to new CAD format.
5.0	Sept 2020	Scott Bagley	Updated Axis camera types
8.0	Nov 2020	Scott Bagley	Updated Axis IP Camera Models
9.0	Aug 2021	David Raposo-De Sousa	Updated CCTV and Access Control Part Numbers
10.0	Feb 2022	Scott Bagley	Addition of Pre-Qualified Vendors and Medeco Locks

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Section 1 - Introduction

The use of Security Systems at City of XXXX facility's and corporate assets should be considered at the onset design of any new construction, and or facility or corporate asset refreshment. By capturing this component early in the overall scope of design, it will ensure that the technology required to enhance and provide City staff and its citizens with a safe work and municipal government environment, will fit seamlessly into the intended design and use of the asset.

The application, type of technology, and the specific equipment applied to all City facilities and assets, must adhere to the applicable legislated requirements and guidelines, as well as the City's overall design criteria and corporate wide capital investment.

Where the City is the owner of the facility, and third party tenants occupy portions of the building, Security Systems may be installed and administrated by the City, on behalf of the tenant. Tenants, who wish to install and administrate Security Systems within their own leased areas, may do so.

Where the City is a tenant in a facility, owned and operated by a third party, the Security Systems that are installed in public areas that are designed for City business practice (i.e. hallways, service counters) and that are installed and operated within the City's leased areas must be connected to the City's Security servers for administration and programming. Where the City is a tenant, and access to the facility is through common space, it is requested that Access Control measures are operated by the City's server to provide access for City staff to the leased areas. Areas that are not included as part of the leased space by the City, are not identified in this document. Security Systems required by the facility owner / operator shall be specified through their own requirements.

Internal Design Consultation

The Security Systems department of the City of Brampton is responsible for the internal consultation, review of proposed security system designs and layouts as provided by external consultants, and act as the City's representative to approve and accept systems that are incorporated in the design of any project. This internal consultation process ensures that the City's practices on the use and application of various security systems is adhered to and applied to the existing administration and operation of the devices.

Applicable Security Systems

The City of Brampton applies in various degrees, equipment and devices that are in some cases duplicate in function but are all operated by independent controllers. Where integration of equipment and devices are required in the design by the City, they are linked and operated through the system servers, not through device to device communications. Below are the basic foundations of the Security Systems that are deployed by the City of Brampton.

Closed Circuit Surveillance Systems (CCTV) – Include, but are not limited to;

- IP fixed and pan-tilt-zoom cameras, requiring network PoE/PoE+/hPoE/hPoE+ Cat 6a cabling connected to the City's IT or a local Security LAN infrastructure, that provide high quality video images to a network connected recording device.
- Managed networked recording device that is installed locally to the facility and accepts video images from IP and Analogue cameras and accepts hot swappable Hard Disk Drives and is capable of writing to DAS, NAS or SAN destinations.
- Uninterruptable Power Supply, for both the recording device(s) and the local Security LAN infrastructure, connected to base building power, and where available, circuits that are supported on the building's generator.

Access Control Systems (Card Access) – Include, but are not limited to,

- Intelligent readers with Proximity technology to read and provide door control at various control points, including man access doors, over-head doors, parking gates, and other means of barriers to control movement of people and assets.
- Access Control Controllers that are capable of receiving data from various devices including card readers, motion sensors, and to control output devices based on network server programming. Controllers must be capable of independent control when their network access to the main server is disconnected.
- Uninterruptable Power Supply, for Access Controllers, connected to base building generator circuits where available.

Intrusion Detection Systems (Burglary) – Include, but are not limited to,

- Input devices installed at strategic locations to monitor various environment changes, including motion, device tampering and damage.
- Controllers that receive information from input devices and provides communication out to a monitoring source for response.
- Uninterruptable Power Supply, for Intrusion Controllers, connected to base building generator circuits where available.

Duress Event Station Systems (also known as "Panic" alarms) – Include, but are not limited to,

- Communication devices (Stations) that include microphones, speakers, video displays, and IP enabled cameras installed at strategic locations to allow staff and public the opportunity to engage Security Services in a two way video and audio communication.
- Controllers that receive information from two way communication video and audio devices, and allows Security to engage devices in any combination, to engage communication.
- Duress event station systems are to be capable of integration to existing SIP telephony systems operated by COB IT
- Uninterruptable Power Supply, for Controllers, connected to base building generator circuits where available.

Key Control Systems – Include, but are not limited to,

- Networked electronic key cabinets that store and secure key rings.
- Controllers that control the distribution of keys based on configured programming and user access levels.
- Uninterruptable Power Supply, for Controllers, connected to base building generator circuits where available.

Section 2 – Environmental Design Criteria Scenarios

Exterior Door Scenarios 1.x (common exterior doors mechanical and electrical rooms)

Exterior Door Scenario 1.1	CCTV	Access	Intrusion	DES	Key Cont
Description: Exterior doors that lead directly into City staff only work environments that require regular access into the area.	Yes	Yes	Yes	No	N/A
Exterior Door Scenario 1.2	CCTV	Access	Intrusion	DES	Key Cont
Description: Exterior doors that lead directly into City staff only work environments that are intended for emergency egress only from the office area to the exterior.	Yes	No	Yes	No	N/A
Exterior Door Scenario 1.3	CCTV	Access	Intrusion	DES	Key Cont
Description: Exterior doors that lead directly into common public areas designated as a regular means of entry into the facility.	Yes	Yes	Yes	Yes	N/A
Exterior Door Scenario 1.4	CCTV	Access	Intrusion	DES	Key Cont
Description: Exterior doors that lead directly into common public areas designed as a means of emergency egress only from the interior to the exterior of the facility.	Yes	No	Yes	No	N/A
Exterior Door Scenario 1.5	CCTV	Access	Intrusion	DES	Key Cont
Description: Exterior doors that lead directly into Mechanical / Electrical / Building Operational Environments that are used by the City.	Yes	Yes	Yes	No	N/A
Exterior Door Scenario 1.6	CCTV	Access	Intrusion	DES	Key Cont
Description: Exterior doors that lead directly into areas that are leased to tenants, where the City is the landlord.	Yes	No	Yes	No	N/A
Exterior Door Scenario 1.7	CCTV	Access	Intrusion	DES	Key Cont
Description: Exterior doors that lead directly into staff common areas used as kitchenettes, lunchrooms, etc.	Yes	Yes	Yes	Yes	N/A
Exterior Door Scenario 1.8	CCTV	Access	Intrusion	DES	Key Cont
Description: Exterior doors (including Over Head doors) that lead directly into City space that is used as a loading / shipping dock environment.	Yes	Yes	Yes	Yes	N/A

Exterior Door Scenario 1.9 (updated in V 2.0)	CCTV	Access	Intrusion	DES	Key Cont
Description: Exterior doors (including Over Head doors) that lead directly into City space that is used primarily as a shipping / receiving area / service counter environment.	Yes	Yes	Yes	Yes	N/A

Interior Door Scenarios 2.x (common interior doors including IT, mechanical and electrical rooms)

Interior Door Scenario 2.1	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior doors that lead directly into City staff only office style work environments that require regular access into the office area.	Yes	Yes	No	Yes	N/A

Interior Door Scenario 2.2	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior doors that lead directly into City staff only office work environments that are intended for egress only from the office area.	Yes	No	No	No	N/A

Interior Door Scenario 2.3	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior doors that lead directly into common public areas from other areas where the public may have general access.	Yes	No	No	Yes	N/A

Interior Door Scenario 2.4	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior doors that lead directly into common public areas from other areas where the public may have access, but is owned and operated by a third party (non-City)	Yes	Yes	Yes	No	N/A

Interior Door Scenario 2.5	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior doors that lead directly into boardroom type environments that are within areas already under access control.	No	No	No	No	N/A

Interior Door Scenario 2.6	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior doors that lead directly into boardroom type environments that are not within areas already under access control.	Yes	No	No	No	N/A

Interior Door Scenario 2.7	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior doors that lead directly into IT related rooms where access is shared with building operational trades and is used by the City	Yes	Yes	No	Yes	N/A
Interior Door Scenario 2.8	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior doors that lead directly into Mechanical / Electrical / Building Operational environments that are used by the City.	Yes	Yes	No	Yes	N/A

Interior Door Scenario 2.9	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior doors that lead directly into staff common areas used as kitchenettes, lunchrooms, etc, that are within areas already under access control.	No	No	No	No	N/A

Interior Door Scenario 2.10	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior doors that lead directly into staff common areas used as kitchenettes, lunchrooms, etc, that are not within areas already under access control.	Yes	Yes	No	No	N/A

Interior Door Scenario 2.11	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior doors that lead directly into common IT related rooms where access is primarily used by IT authorized staff and higher level of control is required to protect the infrastructure within the room. <i>(Does not include doors leading into a Main Server Room, see 3.x Scenarios)</i>	Yes	Yes	No	Yes	N/A

Interior High Security Door Scenarios 3.x (doors leading into high security areas including offices and workspace environments)

Interior Door Scenario 3.1	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior doors that lead directly into a high security environment for the purpose of a Operational Control Room (i.e. Security Operational Control Room, Traffic Operations Centre).	Yes	Yes	No	Yes	Yes

Interior Space with Transaction Location Scenario A.x (common reception and service counter environments)

Interior Space Scenario A.1	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior Service Counter where the primary transactions do not include values greater than \$50 (Including Transit environments)	Yes	Yes (after hours service counter separation)	Yes	Yes	N/A

Interior Space Scenario A.2	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior Service Counter where the primary transactions include values greater than \$50, and where the public may also register disputes and or file legal actions. (Including Transit environments)	Yes	Yes (24 hour service counter separation)	Yes	Yes	N/A

Interior Space Scenario A.3	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior Reception / Service desk where the public may request general information regarding the City and its services related to the facility and or asset. No financial transactions are conducted at this location. (Including Transit environments)	Yes	Yes (after hours service counter separation)	Yes	Yes	N/A

Interior Space Scenario A.4	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior Reception / Service desk where the public may request access to a City Councilor or Official whose office is served by this control point. No financial transactions are conducted at this location.	Yes	Yes (after hours service counter separation)	No	Yes	N/A

Interior Space Scenario A.5 (updated in V 2.0)	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior Reception / Service desk where transactions include pick-up / drop-off of small packages that are part of shipping / Receiving processes. Financial transactions do not take place in this environment.	Yes	Yes (after hours service counter separation)	Yes	Yes	N/A

Interior Space with High Security Scenario B.x (interior high value or confidential storage requirements and vault environments)

Interior Space Scenario B.1	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior Storage Room, where the items inside may contain personal staff property (i.e. Jackets, Boots) and general City stationary property.	No	No	No	No	N/A

Interior Space Scenario B.3	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior Storage Room, where the items inside may contain staffing and high level confidential records regarding City business and operations.	Yes	Yes	No	Yes	N/A

Interior Space Scenario B.2	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior Storage Room, where the items inside may contain general and confidential records regarding City business and operations.	No	Yes	No	Yes	N/A

Interior Space Scenario B.4	CCTV	Access	Intrusion	DES	Key Cont
Description: Interior Storage Room, where the items inside may contain valuables, currency, Negotiable items and legal material. (i.e. Vault style room)	Yes	Yes	Yes	Yes	N/A

Elevator Scenarios E.x

Elevator Scenario E.1	CCTV	Access	Intrusion	DES	Key Cont
Description: Elevator – where the primary operation is by public and staff who require access to various open and secured floors.	Yes	Yes	No	Yes	N/A

Elevator Scenario E.2	CCTV	Access	Intrusion	DES	Key Cont
Description: Elevator – where the primary operation is by staff only who require access to	Yes	Yes	No	Yes	N/A

various open and secured floors.

Elevator Scenario E.3	CCTV	Access	Intrusion	DES	Key Cont
Description: Elevator – where the primary operation is by contractors and operational maintenance staff who require access to various open and secured floors. (typical “service elevator”)	Yes	Yes	No	Yes	N/A

Elevator Scenario E.4	CCTV	Access	Intrusion	DES	Key Cont
Description: Elevator – where the primary operation is by public and staff who require access to various open floors that are not control (typical in a parking garage)	Yes	No	No	Yes	N/A

Outdoor Compound Scenario’s C.x

Outdoor Compound Scenario C.1	CCTV	Access	Intrusion	DES	Key Cont
Description: Compound where there is only COX access and has 100% perimeter fencing with one or more vehicle access points and one or more pedestrian access points. <i>The compound stores vehicles and other high value equipment assets. (seasonal and year round)</i>	Yes	Yes	Possible	Yes	N/A

Outdoor Compound Scenario C.2	CCTV	Access	Intrusion	DES	Key Cont
Description: Compound where there is only COB access and has 100 % perimeter fencing with one or more vehicle access points and one or more pedestrian access points. <i>The compound typically does not store vehicles and other high value equipment assets, but does store operational material such as stones, soil and other consumable items. (seasonal and year round)</i>	Yes	Yes	No	Yes	N/A

Outdoor Compound Scenario C.3	CCTV	Access	Intrusion	DES	Key Cont
Description: Compound where there is COB and or shared (3 rd party) access and has 100% perimeter fencing with one or more vehicle access points and one or more pedestrian access points. The primary use of this area is typically for vehicle traffic only during operational hours. <i>The compound typically does not store vehicles, high value assets and other</i>	Yes	Yes	No	No	N/A

<i>operational materials. (seasonal and year round)</i>					
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Outdoor Compound Scenario C.4	CCTV	Access	Intrusion	DES	Key Cont
Description: Compound where there is COX and shared (3 rd party) access and has 100% perimeter fencing with one or more vehicle access points and one or more pedestrian access points. <i>The compound stores vehicles and other high value equipment assets. (seasonal and year round)</i>	Yes	Yes	No	No	N/A

Outdoor Compound Scenario C.5	CCTV	Access	Intrusion	DES	Key Cont
Description: Compound where there is COX and shared (3 rd party) access and has 100 % perimeter fencing with one or more vehicle access points and one or more pedestrian access points. <i>The compound typically does <u>not</u> store vehicles and other high value equipment assets, but does store operational material such as stones, soil and other consumable items. (seasonal and year round)</i>	Yes	Yes	No	No	N/A

Parking Garage Scenarios

Parking Garage Scenario G.1	CCTV	Access	Intrusion	DES	Key Cont
Description: Common Public and COB staff parking access areas including parking stalls and roadways.	Yes	No	No	Yes	N/A

Parking Garage Scenario G.2	CCTV	Access	Intrusion	DES	Key Cont
Description: Common Public and COB staff Elevator Lobby areas leading to the exterior and or common parking stalls and roadways.	Yes	No	No	Yes	N/A

Parking Garage Scenario G.3	CCTV	Access	Intrusion	DES	Key Cont
Description: COB staff only parking access areas including parking stalls and roadways where the public may have pedestrian access.	Yes	No	No	Yes	N/A

Parking Garage Scenario G.4	CCTV	Access	Intrusion	DES	Key Cont
Description: COB staff only parking access					

areas including parking stalls and roadways where the public does not have normal access.	Yes	Yes	No	Yes	N/A
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Parking Garage Scenario G.5	CCTV	Access	Intrusion	DES	Key Cont
Description: COB staff only access areas related to Parking Garage Operations that would not be covered under 1.x, 2.x, 3.x, A.x or B.x scenarios.	Yes	Yes	Possible	Yes	N/A

Parking Lot (outdoor with open sky) Scenarios

Parking Lot Scenario L.1	CCTV	Access	Intrusion	DES	Key Cont
Description: Common Public and COX staff parking access areas including parking spots and roadways.	Yes	No	No	No	N/A

Parking Lot Scenario L.2	CCTV	Access	Intrusion	DES	Key Cont
Description: COB staff only parking access areas including parking spots and roadways where the public may have pedestrian access.	Yes	No	No	No	N/A

Parking Lot Scenario L.3	CCTV	Access	Intrusion	DES	Key Cont
Description: COB staff only parking access areas including parking stalls and roadways where the public does not have normal access.	Yes	Yes	No	Yes	N/A

Parking Lot Scenario L.5	CCTV	Access	Intrusion	DES	Key Cont
Description: COB staff only access areas related to Parking Lot Operations that would not be covered under 1.x, 2.x, 3.x, A.x or B.x scenarios.	Yes	Yes	Possible	Yes	N/A

Service Garage (Indoor Storage and Mechanical Garage) Scenarios

Service Garage Scenario S.1	CCTV	Access	Intrusion	DES	Key Cont
Description: COB staff only areas where the storage of vehicles and high value equipment assets.	Yes	Yes	Possible	Yes	N/A

Service Garage Scenario S.2	CCTV	Access	Intrusion	DES	Key Cont
Description: COB staff only areas where the mechanical maintenance and cleaning of COB vehicles take place.	Yes	Yes	Possible	Yes	N/A

Section 3 – Equipment Specifications

Part 1 – General Requirements

1.1 General Conditions

- .1 The Supervisor, Security Systems with the City of Brampton, will be the designated contact for the owner / client.
- .2 All submitted system designs and proposals are to include all required client and server software licenses to ensure full system functionality and access for Security Systems staff.
- .3 The vendor will provide evidence of their status as a certified vendor as well as current technical certifications for installation staff for all March Networks, RBH, and Commend products being installed at any City of Brampton location. Acceptable evidence is a letter indicating that the integrator is a vendor in good standing with the manufacturer along with copies of all technician certifications, or a list of certified technicians, with the level of certification achieved from the manufacturer.

1.2 Submittals

- .1 For new construction projects, the proposal submitted by the security equipment vendor shall include the follow:
 - .1 Current and future state system architecture drawings.
 - .2 System riser drawing indicating cabling pathways.
 - .3 A functional narrative describing the operation of the system as a whole, as well as at the individual component level; including any 3rd party system integrations and data or manual system input dependencies.
 - .4 Logical network architecture drawing including a schedule of all required ports and protocols, and data flows between system elements and third party applications i.e. Active Directory, Mail Services, 3rd party integrations, etc.
 - .5 Equipment schedules for all hardware that clearly identifies each installed component by make and model number.
 - .6 Data sheets indicating the functional specifications of each unique device are to be submitted as part of the proposal submittal.
 - .7 Letters from ACMS, CCTV, Intrusion, and Intercom manufacturers indicating the company's current status as a certified vendor and installer of the products.

1.3 Quality Assurance

- .1 All components shall be CSA and/or ULC approved listed and labelled.
- .2 The bidder shall be a certified reseller in good standing of the security systems and components selected and will employ staff with current training certifications said systems and components.
- .3 The City of Brampton requires that all low voltage cabling shall the minimum specifications detailed below:

- .1 Utilize cabling, patch panels, connectors, etc. from the following brands: Corning, Belden, Commscope, Provo, and specialty brands as required and approved by COB Security Systems Staff.
- .2 Provide cabling, patch panels, connectors that are from the same manufacturer to ensure end to end compatibility and compliance with cabling manufacturer extended warranty programs.

1.4 System Documentation

- .1 Upon final acceptance of the installed system or components by the City of XXXX Supervisor, Security Services, the integrator shall provide a set of system documentation that includes:
 - .1 All of the items listed in 1.2.1.1 through 1.2.1.6 for the system as installed and accepted by the client.
 - .2 Documentation of each installed component including:
 - .1 Make
 - .2 Model
 - .3 Serial Number
 - .4 COB Asset Label # where applicable
 - .5 Installation location
 - .6 Cable source termination location and cable ID
 - .7 Device specific configuration information i.e. O/S, CPU, RAM, HDD for NVRs, servers, and workstations, IP addressing information for network connected devices, camera installation parameters (height, lense, housing, description of FOV, live view and recording stream settings), etc. All device network configuration information will be provided to the security vendor by City of Brampton Security Services staff.
 - .3 Configuration backups of all system devices capable of exporting a backup file in electronic format.

Part 2 – Products and Requirements

2.1 Supplies and System

- .1 The door access control system specified herein is the product of RBH Access Technologies Inc. ([http:// http://www.rbh-access.com/](http://http://www.rbh-access.com/)) and is known as “Axiom”. No other equivalent access control systems will be considered.
- .2 The card readers specified herein are the product of HID Global (<https://hidglobal.com>). No other equivalent card readers will be considered.
- .3 The enterprise video management system specified herein is the product of March Networks Corporation (<https://marchnetworks.com>) and is known as “Command”. No other equivalent video management systems will be considered.
- .4 The network connected digital video recording devices specified herein are the product of March Networks Corporation (<https://marchnetworks.com>). No other equivalent video management systems will be considered.
- .5 The IP and analog cameras specified herein are the products of Axis Communications (<https://axiscommunications.com>) and Panasonic (<https://na.panasonic.com/ca/safety-security/video-surveillance/>). No other equivalent IP or analog cameras will be considered.
- .6 The intrusion detection system specified herein is the product of Digital Security Controls by Tyco (<https://www.dsc.com/>). No other equivalent intrusion detection system will be considered.
- .7 The intercom and paging systems specified herein are the product of Commend International (<https://www.commendusa.com/>). No other equivalent intercom and paging systems will be considered.
- .8 The Layer 2 and Layer 3 network switching solutions specified herein are the product of Cisco Systems Inc. (https://www.cisco.com/c/en_ca/index.html). No other equivalent networking products will be considered.
- .9 The network media extension devices specified herein are the product of Black Box Corporation (<https://www.blackbox.com/en-ca>). No other equivalent network media extension technology will be considered.
- .10 The battery backup systems specified herein are the product of APC by Schneider (<https://www.apc.com/ca/en/>). No other equivalent battery backup systems will be considered.
- .11 The equipment racking systems specified herein are the product of Middle Atlantic Products (<https://www.middleatlantic.com/>). No other equivalent battery backup systems will be considered.

- .12 The computers and server equipment specified herein are the product of Dell or HP (<https://www.dell.com> or <https://www.hp.com>). No other computer or server equipment will be considered.

2.2 Warranty

- .1 The System Supplier shall provide a warranty on the system which shall include all necessary labor and equipment to maintain the system(s) in full operation for a period of two years from the date of acceptance.
- .2 System Supplier shall provide, free of charge, product firmware/software upgrades throughout the warranty period for any product feature enhancements.

2.3 Access Control System General Requirements

- .1 Supply and install a complete and operational door access control system consisting of control panels, door contacts, RTE motion sensors, electric strikes, magnetic locks, proximity card readers, interface accessories, interface hardware, power and signal cables, conduits, wireways, power supplies, necessary software, programming and commissioning.
- .2 Systems shall be as shown on the drawings and herein specified.
- .3 All cabling for the door access control system shall be run in conduit, unless otherwise indicated on the drawings or advised by City of Brampton Security Services staff and shall be concealed in finished areas. All cabling to meet City of Brampton standards stated in section 1.3.3.
- .4 The normal power supply to the door access system shall be 120 Volts 60 HZ taken from the building service at the closest panel. Provide new breaker in existing panel to match existing breakers if required. Power from the building service shall be dedicated to the door access system and not shared by any other system.
- .5 Ensure equipment manufacturer provides all information regarding wiring, conduit runs and component requirements before tendering. Owner will not be responsible for added costs and charges due to additional manufacturer's requirements.
- .6 Provide network switch for communication and camera power supply over PoE/PoE+/hPoE/hPoE+ with capacity based on the noted project equipment matrix and design layouts sized to suit the total connected camera load plus 25% PoE capacity and 25% port capacity to allow for future expansion.
- .7 The vendor shall all engage in all commercially reasonable efforts to supply and install edge devices that have undergone the following configuration hardening as a minimum security standard:

- .1 Disabling any non-encrypted communication protocols i.e. FTP via Port 21, SMTP, POP server access, web access via port 80, etc.
- .2 Updating default administrator passwords
- .3 Disabling any device discovery protocols and SNMP
- .4 Enabling secure communications protocols i.e. HTTPS via SSL, SecureFTP via SSH, etc.

2.4 Closed Circuit Television System General Requirements

- .1 Supply and install a complete and operable closed circuit television (CCTV) system consisting of visible and near visible spectrum cameras complete with lenses, housings and mounting hardware as specified in the drawings CCTV schedule, IP and hybrid network video recorder(s), UPS, alarm interface accessories (where specified), interface hardware, power and signal cables, network connections, conduit where required, wireways, console rack, network switches for communication and PoE supply, auxiliary power supplies as required by environmental housings, plywood backboards, necessary software, programming and commissioning.
- .2 Provide IP visible and near visible spectrum cameras at the designated locations as shown on the drawings.
- .3 Provide network switch for communication and camera power supply over PoE/PoE+/hPoE/hPoE+ with capacity based on the noted project equipment matrix and design layouts sized to suit the total connected camera load plus 50% PoE capacity and 25% port capacity to allow for future expansion.
- .4 All cabling to meet City of Brampton standards stated in section 1.3.3.
- .5 Ensure equipment manufacturer provides all information regarding wiring, conduit runs and component requirements before tendering. City will not be responsible for added costs and changes due to additional manufacturer's requirements.
- .6 All NVRs shall be housed in the designated lockable cabinet at the location shown on the drawings. All net new cabinets to provide 50% spare rack space, measured in rack units (U) to allow for system expansion.
- .7 Vendors must notify the City immediately if the installation of a camera will exceed 90 meters from the location of its installation to the location where it is connected to the network switch for this project, unless the use of ethernet extension technology are specified for the specific camera already.
- .8 The vendor shall all engage in all commercially reasonable efforts to supply and install edge devices that have undergone the following configuration hardening as a minimum standard:

- .1 Disabling any non-encrypted communication protocols i.e. FTP/21, SMTP, POP server access, web access via port 80, etc.
- .2 Updating default administrator passwords
- .3 Disabling any device discovery protocols and SNMP
- .4 Enabling secure communications protocols i.e. HTTPS via SSL, SecureFTP via SSH, etc.

2.5 Intrusion Detection System General Requirements

- .1 Supply and install a complete and operational intrusion alarm system consisting of alarm panels, door contacts, motion sensors, interface accessories, interface hardware, power and signal cables, conduits, wireways, power supplies, necessary software, programming and commissioning.
- .2 Systems shall be as shown on the drawings and herein specified.
- .3 All wiring for the intrusion alarm system shall be run in conduit, unless otherwise indicated on the drawings or advised by the City of Bra Corporate Security Services and shall be concealed in finished areas.
- .4 The normal power supply to the intrusion detection system shall be 120 Volts 60 HZ taken from the building service at the closest panel. Provide new breaker in existing panel to match existing breakers if required. Power from the building service shall be dedicated to the intrusion detection system and not shared by any other system.
- .5 Ensure equipment manufacturer provides all information regarding wiring, conduit runs and component requirements before tendering. Owner will not be responsible for added costs and charges due to additional manufacturer's requirements.
- .6 The vendor shall all engage in all commercially reasonable efforts to supply and install edge devices that have undergone the following configuration hardening as a minimum standard:
 - .1 Disabling any non-encrypted communication protocols i.e. FTP/21, SMTP, POP server access, web access via port 80, etc.
 - .2 Updating default administrator passwords
 - .3 Disabling any device discovery protocols and SNMP
 - .4 Enabling secure communications protocols i.e. HTTPS via SSL, SecureFTP via SSH, etc.

2.6 Intercom System General Requirements

- .1 Supply and install a complete and operational intercom system consisting of one or more of the following items: master stations, client stations, interface accessories, interface hardware, power and signal cables, conduits, wireways, power supplies, necessary software, programming and commissioning.
- .2 Systems shall be as shown on the drawings and herein specified.
- .3 All wiring for the intercom alarm system shall be run in conduit, unless otherwise indicated on the drawings or advised by the City of Brampton Corporate Security Services and shall be concealed in finished areas.
- .4 Ensure equipment manufacturer provides all information regarding wiring, conduit runs and component requirements before tendering. Owner will not be responsible for added costs and charges due to additional manufacturer's requirements.
- .5 Provide network switch for communication and intercom client/master station power supply over PoE/PoE+/hPoE/hPoE+ with capacity based on the noted project equipment matrix and design layouts sized to suit the total connected camera load plus 50% PoE capacity and 25% port capacity to allow for future expansion.

2.7 Network Switches General Requirements

- .1 The vendor shall all commercially reasonable efforts to supply and install switches that have undergone the following configuration hardening as a minimum security standard:
 - .1 Disabling any non-encrypted communication protocols i.e. FTP/21, SMTP, POP server access, web access via port 80, etc.
 - .2 Updating default administrator passwords
 - .3 Disabling any device discovery protocols and SNMP
 - .4 Disabling VLAN 1
 - .5 Enabling secure web communications via SSL and secure remote session access via SSH
 - .6 Disabling any unused ports
 - .7 Configuring any connected ports with MAC address access list for the connected device
- .2 Systems shall be as shown on the drawings and herein specified.
- .3 Provide network switches that allow for capacity expansion above and beyond the total connected camera load at the time of installation. Additional capacity

to be defined as 50% additional PoE capacity and 25% additional port capacity to allow for future expansion.

- .4 Where available switches will be configured to utilize connection resiliency protocols such as LACP for connections to servers and inter-switch links to maximize connection and device uptime.

2.8 Network Media Extenders General Requirements

- .1 Supply and install network media extenders that meet the following criteria:
 - .1 Available in multiple form factors from single channel through high density rackmount solutions.
 - .2 Support both copper and fibre media.
 - .3 Rackmount solutions to provide 25% expansion capacity for adding new connections.
- .2 Systems shall be as shown on the drawings and herein specified.

2.9 Backup Power Supplies General Requirements

- .1 Supply and install backup power solutions that meet the following criteria:
 - .1 Rack mountable in standard 19 inch rack/enclosures
 - .2 Provide 15 minute runtime for all connected devices mounted in the rack
 - .3 Provide 25% expansion capacity for new devices.
 - .4 Support network management and monitoring via an installed or embedded network monitoring card for all UPS's supporting all Windows/Linux server installations and 16 and 32 channel rackmount NVR applications. UPS application supporting 8 channel NVRs and workstations/PCs do not require network monitoring capability.
- .2 The vendor shall all engage in all commercially reasonable efforts to supply and install edge devices that have undergone the following configuration hardening as a minimum standard:
 - .1 Disabling any non-encrypted communication protocols i.e. FTP/21, SMTP, POP server access, web access via port 80, etc.
 - .2 Updating default administrator passwords
 - .3 Disabling any device discovery protocols and SNMP
 - .4 Enabling secure communications protocols i.e. HTTPS via SSL, SecureFTP via SSH, etc.
- .3 Systems shall be as shown on the drawings and herein specified

2.10 Equipment Room Fittings General Requirements

- .1 Supply and install equipment racking solutions that meet the following criteria:
 - .1 Full height (37U), half height, and wall mount configurations.

- .2 Full height and half height racks to be 27 inch depth to allow for the installation of up to 22 inch depth network appliances.
 - .3 Provide 25% expansion capacity, measured in rack units (U) for the installation of new devices.
 - .4 At a minimum will include:
 - .1 Locking front and rear doors.
 - .2 Removable side panels
 - .3 Active ventilation
 - .4 Cabling management
 - .5 Rack chassis mounted vertical power distribution strips
 - .5 Provide thermal output calculations for all hardware installed in the rack to ensure adequate active ventilation is provided with the rack.
- .2 Systems shall be as shown on the drawings and herein specified

2.11 Computers and Servers General Requirements

- .1 The vendor shall all commercially reasonable efforts to supply and install laptops, workstations, and servers that have undergone the following configuration hardening as a minimum security standard:
 - .1 Disabling any non-encrypted communication and file sharing protocols i.e. uPnP, Windows File Sharing
 - .2 Updating default administrator account passwords
 - .3 Apply all available O/S updates
 - .4 Install and update antivirus/antimalware application
 - .5 Lock down system BIOS with a password
 - .6 Disable all remote boot options in BIOS i.e. PXE, USB
 - .7 Ensure all built-in Windows Exploit protections are enabled for Windows 10 O/S machines.
 - .8 Apply all system hardening patches, fixes, and updates as specified in security application provider system hardening guides and the Center for Internet Security (CIS) server hardening guidelines.
- .2 Systems shall be as shown on the drawings and herein specified.
- .3 Provide three (3) year next day onsite support warranty for all laptops and workstations.
- .4 Provide five (5) year four (4) hour onsite support warranty for all servers.
- .5 All computers, workstations, and laptops shall utilize solid state hard drives for the primary O/S drive.
- .6 All storage arrays will exclusively be equipped with enterprise rated hard drives. Acceptable manufacturers are HGST (Hitachi), WDC, Toshiba, and Seagate.

Section 3 Accepted Part Numbers by System Type

3.1 The following are the acceptable Access Control Management System components and hardware:

Manufacturer	Item Description / Part Number
RBH	UNC-500-822M
RBH	RC2M Reader Controller
RBH	IOC-16 Input Output Controller
RBH	ENCL1-PS
RBH	ENCL2-PS
ATC Frost	TCE150161 16VAC 150 VA Transformer
Tyco/DSC	PC-100 ASCII Gateway for DSC intrusion alarms
Camden Door Controls	Camden CX12
Camden Door Controls	Camden CX 32
Camden Door Controls	Camden CX WEC13
Dorma Kabba	RCI 8310/8320 Mag-lock
Assa Abloy	HES 1600 CLB Complete Pack
Assa Abloy	HES 9600
Assa Abloy	HES 5200
Assa Abloy	HES 9400
BOSCH	DS160 Request to Exit Motion
STI	UB-1 Request to Exit Pushbutton
STI	SS2472EM-EN EMERGENCY STOPPER STATION
ELK	912 SPDT Relay
HID	Multiclass RP-40 Multi-card Reader 920PTNNKO

3.2 The following are the acceptable Network Video Recorders:

Manufacturer	Item Description/Part Number
March Networks	8732 with 4 X 6TB
March Networks	8708 With 2 X 6TB
March Networks	8704 with 2 X 4TB
March Networks	9132 with 40TB of Storage
March Networks	9248 with 80TB of Storage
March Networks	9264 with 80TB of Storage

3.3 The following are the acceptable analog and IP CCTV cameras and accessory equipment:

Manufacturer	Part Number
Axis Communications	M3065-V
Axis Communications	Q6000-E MK II
Axis Communications	P5654-E
Axis Communications	P3245-LV MKII
Axis Communications	P3245-LVE MKII
Axis Communications	M3057-PLVE MKII
Axis Communications	T8133
Axis Communications	T8134
Axis Communications	T94AO1D
Axis Communications	T91A64
Axis Communications	T91D62
Axis Communications	T91L61
Panasonic	Panasonic WV-X6531N
Panasonic	Panasonic WV-S2531LN
Panasonic	Panasonic WV-SFN480
Panasonic	Panasonic WV-SFV481
Panasonic	Panasonic WV-Q122A
Panasonic	Panasonic WV-Q124
Panasonic	Panasonic WV-Q121B

3.4 The following are the acceptable intrusion detection systems equipment and accessories:

Manufacturer	Item Description / Part Number
Tyco/DSC	PC1864NK Control Panel with Large Cabinet
Tyco/DSC	3G2060R GSM Communicator
Tyco/DSC	PK-5500 LCD
Tyco/DSC	DSC-BV500GB
Tyco/DSC	PC5108
Interlogix	1078
Interlogix	1085T
Potter	ODC59A
Bosch	ISCPR1W6
ATC Frost	FTC3716
Eyez On	EVL4CG

3.5 The following are the acceptable intercom stations and accessories:

Manufacturer	Item Description
Commend	ES833A
Commend	ES831A
Commend	ES2GBB
Commend	ES2GRH
Commend	Intercom Server GE 800
Commend	Intercom Server GE 300
Commend	ET901WP
Commend	G3-IP-4B
Commend	G3-GED-4B
Commend	G8-IP-4B
Commend	L8-IP-8B
Commend	L8-IP-8P
Commend	ES2GBB
Commend	L8-ICX
Commend	G8-LAN-8
Commend	L8-LAN-16
GE/Sentrol	GE3040
Safety Technology International	SS2472EM-EN

3.8 The following are the acceptable managed PoE/PoE+ network switches:

Manufacturer	Item Description/Part Number
Cisco Systems	Cisco SG300-10P
Cisco Systems	Cisco SG110-24HP
Cisco Systems	Cisco SG300-28P

3.9 The following are the acceptable cable types:

Manufacturer	Item Description/Part Number
Provo	Network - 9924104L5E-350GN FT6
Provo	Access Control – 8913 FT4
Provo	Access Control – 998913 FT6

3.11 The following are the acceptable uninterruptible power supplies, communication modules, and replacement batteries:

Manufacturer	Item Description
APC by Schneider Electric	SMT1500RM2UC
APC by Schneider Electric	AP9630
APC by Schneider Electric	BR1500GCA
APC by Schneider Electric	RBC115
APC by Schneider Electric	RBC124
APC by Schneider Electric	RBC133

3.12 The following are the acceptable equipment rack part numbers and ancillary racking equipment:

Manufacturer	Item Description/Part Number
Middle Atlantic	DWR-10-22
Middle Atlantic	DWR-16-22
Middle Atlantic	DWR-24-22
Middle Atlantic	WRK-37SA-27
Middle Atlantic	VFD-10
Middle Atlantic	VFD-16
Middle Atlantic	VFD-24
Middle Atlantic	LVFD-37
Middle Atlantic	QFP-2 / 1
Middle Atlantic	QFP-2 / 2
Middle Atlantic	U2 / 1
Middle Atlantic	RLNK-SW815R-SP
Middle Atlantic	PD-815SC

3.13 The following are the acceptable laptop, workstation, server, and data storage unit product lines:

Manufacturer	Item Description / Part Number
Dell	Latitude and Precision Workstation Laptops
Dell	Optiplex Desktops Precision Fixed
Dell	Power Edge Rack Mount Servers
Dell	PowerVault Storage Appliances
HP	zBook Workstation Class Laptops
HP	Z Series Workstations
HP	Hp ProLiant Servers and Storage Arrays

Section 4 – System Specifications

28 10 00 Access Control

28 23 00 Video Surveillance

28 30 00 Security Detection, Alarm and Monitoring

28 50 00 Specialized Systems – Intercom Entry Systems

26 33 00 Battery Equipment

27 11 00 Communications Equipment Room Fittings

27 20 00 Data Communications

27 22 00 Data Communications Hardware

28 10 00 Access Control

General Purpose

- 1.1.1. To establish the technical, functional, jurisdictional, or regulatory and quality requirements for security and access control systems; which are required to be purchased from vendors. Approved technical specifications define the supply and installations of all security and access control systems and identify approved manufacturers and models.
- 1.1.2. The security system shall consist of implementing an integrated networked Access Control and Video Assessment System (ACAMVAS) that shall control personnel access, provide real time intrusion detection alarm monitoring and provide alarm driven video surveillance for the designated buildings and operations in accordance with the requirements and specifications prescribed in these documents and the approved drawings. The security system shall include the following, where applicable:
 - 1.1.2.1. Seamless integration of a digital video management system that will allow system operators to control and maintain the security of the facilities from multiple designated client workstations.
 - 1.1.2.2. Seamless integration of video surveillance systems that provides alarm driven assessment for the intrusion detection equipment at designated facilities.
 - 1.1.2.3. Seamless integration with wireless networked locksets from Assa Abloy or Salto to provide doors with a battery powered solution for access control without the need to pull multiple wiring cables to the door.
 - 1.1.2.4. Commissioning and testing of the systems and equipment installed as required to meet manufacturers' specifications and documented installation procedures, and to the satisfaction of the Owner.
 - 1.1.2.5. Training of the Owner's personnel to: fully operate, and perform routine maintenance on the systems and equipment installed.
 - 1.1.2.6. Provide all associated documentation for the security system upgrades.

1.2 Reference Standards

Underwriters' Laboratories of Canada (ULC)

- 1.1.2.7. American National Standards Institute (ANSI) Standards
- 1.1.2.8. Ontario Building Code
- 1.1.2.9. CANASA (Canadian Alarm and Security Association)
- 1.1.2.10. CFAA (Canadian Fire Alarm Association)

All products comply with the Canadian certifications listed above.

PRODUCTS

SECURITY COMPONENTS

1.1.3. Listed below are the security components that shall be supplied and installed. A detailed specification of each of the security components included in this list is also included.

ACCESS CONTROL AND ALARM MONITORING SYSTEM

General System Specifications

The access control and alarm monitoring system shall be the RBH Access Technologies AxiomV Enterprise system and meets the following design and performance specifications:

- 1.1.3.1. The system shall be a modular, networked access control and alarm monitoring system, comprised of proven commercial off the shelf components, capable of handling large proprietary corporations with multiple remote sites, alarm monitoring, video imaging, badging, paging integration, CCTV integration, interactive guard tour, mapping, visitor management, email notification, third party monitoring, BAS integration and asset management. The system shall assure long time performance, cost effective upgrade capability and allow for easy expansion or modification of inputs, outputs and remote control stations.
- 1.1.3.2. The system control at the central computer location shall be under a single software program control, shall provide full integration of all components, and shall be alterable at any time, depending upon the requirements. Reconfiguration shall be accomplished online through system programming, without hardware changes.
- 1.1.3.3. The Access Control Software system shall utilize Microsoft SQL Server 2008/2012/2016 for data storage and be written expressly for Microsoft SQL Server 2008/2012/2016.
- 1.1.3.4. The system shall have the capability to be networked via a LAN/WAN connection utilizing industry standard TCP/IP communication protocol. The system shall provide encryption via the TCP/IP connection
- 1.1.3.5. The system shall incorporate the use of bi-directional 485 communications and/or Class "A" TCP/IP redundant connections for redundancy and reliability.
- 1.1.3.6. The system shall incorporate "High Availability" Communications so that multiple communication paths are available to all controllers. High availability shall be defined as, "an existing alternate controller shall take over communications in the event the main controller fails. The controller must be located in a separate location to the first."
- 1.1.3.7. The system shall support both manual and automatic responses to alarms entering the system. Each alarm shall be capable of initiating a number of different actions, such as camera switching, activation of remote devices and door control.

- 1.1.3.8. The system shall provide unlimited levels of emergency codes to allow the system to operate in different security levels depending on local threat level e.g. code black = bomb threat and building locks down.
- 1.1.3.9. The system shall provide both supervised and non-supervised alarm point monitoring. Upon recognition of an alarm, the system shall be capable of switching CCTV cameras and automatically creating a popup window for video for the associated alarm. The system shall be capable of arming or disarming alarm points both manually and automatically, by time of day, and by day of week.
- 1.1.3.10. Access control functions shall include validation based on time of day, day of week, holiday scheduling, site code verification, automatic or manual retrieval of card/tagholder photographs, and access validation based on positive verification of card/tag, card/tag/PIN, card/tag and video.
- 1.1.3.11. The system programming shall be user friendly, and capable of being accomplished by personnel with no prior computer experience. The programming shall be menu driven and include online "Help" with the use of F1 hotkey to automatically call the proper help information to the screen. The software shall utilize drop boxes for all previously entered system required data.
- 1.1.3.12. After installation, the Owner shall be able to perform basic hardware configuration changes. These hardware configuration changes shall include, but not be limited to, door open time, door contact shunt time, point and reader names, when and where a card/tagholder is valid, and the ability to add or modify card/tag databases as desired without the services of the Manufacturer or Manufacturers Dealer.
- 1.1.3.13. Equipment repair shall be able to be accomplished on site, by module replacement, utilizing spare components. All equipment shall have pluggable connectors for easy replacement.
- 1.1.3.14. All control components shall include the ability to download operating parameters to any control panel, thus allowing the control panel to provide full operating functions independent of any other system component.
- 1.1.3.15. The system shall be designed in such a way that it does not require enrolment of authorized personnel at each building.
- 1.1.3.16. The system shall provide seamless integration to multiple manufacturers of DVR's and NVR's at the same time.
- 1.1.3.17. The system shall provide seamless integration with external building control systems (BAS), personal safety systems, remote paging and email systems.
- 1.1.3.18. All system events, operator actions and maintenance information shall be stored on the computer hard disk to maintain a permanent record of system activity. The system shall have the capability for manual and automatic back-up of set-up and

system events to either local removable media (optical/magnetic) or remote network resource.

1.1.3.19. All workstations shall be configurable to act as Alarm monitoring centre for the system. All alarms shall be configurable by schedule and workstations will have the ability to acknowledge and clear alarms as a two step process.

1.1.3.20. All workstations shall have the ability to define alarm routing with an unlimited number of Routing levels available to the system.

1.1.4. Interactive Mapping and Graphics

The system shall support an unlimited number of user programmable colour graphic map displays capable of showing the floor plan, location of alarm device, and alarm instructions. Floor plans shall be created in an approved format and shall be capable of being imported from other systems. All of the graphic maps shall be displayed on the CPU monitor. Systems requiring separate display monitors or PC's shall not be acceptable. Maps shall be interactive with dynamic real-time status so that the operator can control all device functions from the map.

1.1.5. Information Storage

All programmed information as well as transactional history shall be automatically stored onto the hard disk for later retrieval.

1.1.6. Information Backup/Retrieval

The CPU shall be capable of transferring all programmed data and transactional history to thumb drive or any logical disk drive. All programmed data shall be restorable from disk in case of system hardware failure.

1.1.7. Communication Rates

The system shall have bi-directional communications and communicate up to 2.5mb/s.

1.1.8. Printers

The system shall support all system printers configured under and supported by the Windows ® operating system.

1.1.9. Pointing Device

The system shall use the pointing device configured under and supported by the Windows ® operating system.

1.1.10. Communication Ports

The system shall support an unlimited number of either serial or TCP/IP ports.

1.1.11. Workstations

The system shall support an unlimited number of active remote workstations. These stations shall be capable of monitoring alarms and changing the database and retrieving transaction records in real time without affecting the other stations.

1.1.12. Networking

The system shall operate with the standard Windows ® networking software.

1.1.13. Database

The database shall be Microsoft SQL Server 2008/2012/2016.

1.1.14. Software Capacities

1.1.14.1. The System server shall have the following minimum requirements. Server 2008/2012, Windows 7, 8.1 and 10 pro, with 2.2 GHz clock speed, 2gig Ram, 40 gig hard drive, CD Rom, Pointing device and video graphics card with 512 on board ram.

1.1.14.2. System software and language development software shall be existing, industry accepted, and of a type widely used in commercial systems. The solutions operating system requirements shall be as identified in 2.2.3. The application software shall have been written in a standard, industry accepted language. All System functions shall be accessible via Windows ® operating systems compliant menu accessed screens. Systems requiring command string control or complex syntax shall not be acceptable. Systems shall not be dependent upon external input other than keyboard.

1.1.14.3. The system software shall include the following features and be configured as a minimum:

- Unlimited reader expansion
- Unlimited card/tagholders in software
- Unlimited simultaneous client PCs
- Unlimited time zones
- 365 user-definable holidays
- Unlimited Access levels
- Access levels for each card/tagholder
- Unlimited alarm input points
- Unlimited output control points
- Unlimited operator passwords with definable privilege levels
- Audible alarm annunciation at the CPU
- Unlimited colour graphic maps displayed on the CPU monitor
- TCP/IP or RS232 interface capability to a CCTV system, which provides automatic, alarm actuated camera switching.

- True 32/64 bit operation
- Operator activation/cancellation dates
- Employee activation/cancellation dates
- Optional Video Imaging/Badging & bar code imprinting

1.1.15. System Administrators shall have the following abilities as a minimum:

- To change any station settings from whatever station they are working on.
- To establish Station Names. Station names shall be user-definable.
- The Station Status dialog shall be available. It shall display a list of stations and their on-line/offline status, along with the names of the logged-on operators.
- Report Printers: Reports as requested by the operators are sent to printers that may reside anywhere on the network.

1.1.16. Alarm Window Description

The system shall facilitate the processing of alerts by using a pop-up alarm window. The Window shall list the system alarms and allow the operator to acknowledge and clear by right-clicking on the event. The alarm window shall indicate time of alarm and response time by the operator. The alarm shall incorporate programmable instruction messages to instruct the operator what he is to do. The alarm will also have an operator action window to log an action into history for the alarm.

1.1.17. Bulk Acknowledgment of Alarms

The system shall provide a means to bulk-acknowledge alarms, so that all alarms can be acknowledged with a single operator action.

1.1.18. Station Routing

The system shall support the routing of alarms to any or all stations. Time schedules can be used to determine which station an alarm is routed to at what time. An alarm may be routed to one station or group of stations during a time schedule and re-routed to another station or group of stations during another time schedule.

1.1.19. Operator Routing

The system shall support the routing of alarms to particular operators, regardless of which station the operator is logged onto.

1.1.20. Menu Configurations

The system software shall allow for the configuration and programming of the controller panel through the use of a simple graphical user interface (GUI). All devices and functions shall be right click configurable for easy operation.

1.1.21. Memory

Memory within each controller panel shall be automatically configured by the system.

1.1.22. Database Updates

The system software shall download/upload information to the controller panels automatically while the controller panels are in communication with the host CPU. A data download may also be initiated manually.

1.1.23. Reporting

The system software shall have the capability to report selectable data by type and by time zone. The system software shall allow the user to generate a report to screen, to printer or to save to a file. The reports shall be exportable to over 30 different file formats. The system shall incorporate the use of an automatic report generator.

1.1.24. Workstations

The system software shall have the capability to report selectable data by type and by time zone to any combination of the system workstations simultaneously.

1.1.25. Serial Ports

All serial ports shall be configured from an easy to follow menu. Systems requiring in depth knowledge of the operating system or CMOS setup for port configuration shall not be acceptable.

1.1.26. Time Zones

1.1.26.1. The system software shall have the capacity for a minimum of 255 user-definable time zones. Each time zone shall allow for a minimum of 16 individual time intervals.

1.1.26.2. The time zones shall be assignable to:

- Card/tagholders
- Outputs
- Alarming reporting functions
- TCP/IP and RS232 message ports
- Doors
- Reports
- Printer operation
- Workstations

1.1.27. Holidays

The system software shall support a minimum of 365 holidays. Holidays shall be considered HI or H2 designation so that there are three distinct holiday times. A holiday shall be capable of starting at any

time/hour during a 24-hour day. Systems requiring holiday start time of midnight shall not be acceptable.

1.1.28. Door Descriptions

Each door in the system shall be identified using logical tagging format and approved by the Owner. Each door description shall be assigned user-definable text of up to 50 characters.

1.1.29. Access Control Modes

Each door may be programmed to switch automatically based on a user defined time schedule between the following modes of operation:

- "CARD/TAG ONLY"
- "CARD/TAG + PIN" – Dual authentication shall be provided for access points requiring the user to use their credential and enter a four digit PIN number.
- "PIN ONLY" – Keypad readers shall be used at doors to prevent access by Alzheimer residents.
- "HIGH SECURITY"
- "TWO PERSON" - To add additional security two people must be required to present cards (or any other credentials) in order to access a secure area.
- "FREE ACCESS"

1.1.30. Duress

If the reader is operating in the "CARD/TAG + PIN" mode or "PIN ONLY" mode, a duress feature shall allow an alternate code to be entered into the keypad for access. The system shall generate an alert and may be linked to control relays for notification of the alarm.

1.1.31. Door Alarms

Each door may be programmed to generate "FORCED DOOR" and "DOOR HELD OPEN" alarms. These alarms shall have the ability to have a user-definable time delay.

1.1.32. Door Alarm Annunciation

In addition to generating an alarm message, the following conditions may activate an output for annunciation:

- FORCED DOOR
- DURESS
- DOOR HELD OPEN (DOOR AJAR)
- VOID CARD/TAG
- DENIED CARD/TAG
- ANTI-PASSBACK VIOLATION

- INPUT DOOR ALARM
- TAMPER
- ALARMS

1.1.33. Alarm Description

Each alarm point may be defined with a plain text description of up to 50 characters.

1.1.34. Alarm Enabling

Alarm points shall be enabled during user-definable time zones and may be manually enabled/disabled from any workstation.

1.1.35. Additional Alarms

The system must also generate alarms for the following:

- Enclosure tampering
- Controller panel communication loss
- Channel 1 Fail /Channel 2 Fail
- Battery Failure
- AC Failure
- Reader Fuse
- Auxiliary Fuse
- Lock Fuse
- Alarm tampering (supervised)

1.1.36. Alarm Supervision

When using supervised alarm points, the system must monitor for “OPEN”, “SHORT”, in addition to “NORMAL/ABNORMAL” conditions.

1.1.37. ASCII Output:

Alarm points shall output an ASCII via RS232 or TCP/IP text command for integration to any other IP commandable device. This command/output shall be an optional, user-definable and transmitted on alarm points going into abnormal state, returning to a normal state, or both.

1.1.38. Outputs

- 1.1.38.1. Shunt relays: User definable outputs may be assigned as shunt relays, allowing access doors to be monitored by third party alarm systems.

1.1.38.2. Relay “on” time: Outputs assigned to control doors shall be user-definable from 1-127 seconds or minutes.

1.1.39. Encryption

The passwords shall be encrypted in the operator database using encryption, to facilitate confidentiality of individual operator passwords.

1.1.40. Operator Access Levels

The system shall provide unlimited operator access levels for the system. All operator actions will be recorded within the system database.

1.1.41. Password Security

The Operator password shall be encrypted to prevent operators from seeing passwords. Passwords shall be up to 20 alphanumeric characters and be case sensitive. Operators must have the right to edit their own password for secrecy.

1.1.42. Partitioning

The System shall incorporate true database partitioning by operator. An operator shall logon anywhere on the system and have the same functionality at any workstation. Operators will be limited to see and control of the system by their operator Access level.

1.1.43. Operator Access Levels

The system shall have the ability to define unlimited user roles. As a minimum, the user roles shall be:

- General Administrator
- Supervisor
- General User
- Privilege levels shall be assignable to, but not limited to the following menu functions:
- View
- Edit
- Edit of any field within the menu
- Select

1.1.44. Operator Activity

All operator activity including specific changes to the database shall be stored for later retrieval and Operators shall be assigned a time zone for the purpose of logging in.

1.1.45. Audit Trail of Database Changes

1.1.45.1. The system shall record changes to the database, including the date, time, operator name and description of the record changed.

1.1.45.2. The audit trail event messages shall record additions, deletions and revisions. The record shall contain a date/time stamp for the change, the logged on operator's name, the table name, a character identifying the change, and a description based upon the Name field from the record, such as the user name, operator name, panel name, reader/door name.

1.1.45.3. The system shall do a full restore or partial depending on operator selection of the data or history files during the back-up process.

1.1.45.4. The system shall allow for viewing of the audit trail.

1.1.45.5. The system shall NOT allow The Audit Trail table to be edited.

1.1.46. Employee Definitions

1.1.46.1. Card Entering:

Card entering shall be easy so that minimal training is required. Card input and changes shall be allowed through direct interface with the event viewer screen. Cards shall have the ability to have multiple access levels or assigned special access levels. Cards may be inactivated from the system while the data remains for reactivation at a later date.

1.1.46.2. Card/tag Data:

The system software shall allow for card/tag numbers up to 18 digits.

1.1.46.3. Employee records:

Employee records shall consist of a minimum of the following:

- Card/tag Number
- Issue level
- Two (2) groups of access level and time zone
- User-definable PIN code
- Facility code
- Anti-passback location and status
- Expiration date
- High Security
- Lock/Unlock privilege
- Code Links
- Track status

- Last door accessed
- 22 user definable searchable text and data fields
- Duration use
- Escort
- Extended shunt (for ADA compliance)
- Passback override

1.1.46.4. Batch Loading:

The system software shall allow groups of card/tags to be input through the use of a card/tag number range or by a batch load employee field.

1.1.47. Reports

1.1.47.1. Data Storage:

All programmed and transactional history is automatically stored to the hard disk for later retrieval.

1.1.47.2. System Function:

The system software shall be capable of generating reports without affecting the real-time operation of the system.

1.1.47.3. Media:

Reports shall be generated from the hard disk, or removable media and exportable to over 30 file formats.

1.1.47.4. Search Criteria:

The database shall be structured such that the operator shall determine the search parameters based on variables available on the individual report menu. Systems requiring the user to type complicated search strings shall not be acceptable.

1.1.47.5. Report Types:

User-definable data reports shall be available for the following information:

- Card/tagholder data
- Door groups
- Time zones
- Doors
- Inputs
- Relays

- Links
- Controller panels
- Operators
- System hardware configuration
- System settings configuration

1.1.47.6. Transaction Reports:

Transaction reports shall be available for the following:

- Card/tag transactions
- Alarm transactions
- Event transactions
- Operator activity
- Time and Attendance

1.1.47.7. Report Scheduling:

The system software shall have the ability to batch reports to any of: screen report, report to a network printer or save a report to a file without operator initiation.

1.1.48. System Guides

1.1.48.1. On Line Help:

The system software shall have on line help available at any point requiring operator input. The help screen shall be accessible by using the standard Windows ® help systems. These help screens shall contain context sensitive information that shall allow the operator to enter correct data without consulting the manual. The help menu shall be accessible to the exact point in software by using the “F1” hotkey.

1.1.49. System Status

1.1.49.1. Real Time Status:

The operator shall be able to monitor via graphical screens, the status of the following in real time:

- Inputs
- Outputs
- Doors

1.1.49.2. Alarm Monitor:

A screen shall be available to monitor alarms and view, at minimum, 99 of the most recent events. The operator shall also have the ability to view additional detail of any event through the use of a single keystroke or click of the mouse.

1.1.50. Graphics

1.1.50.1. Graphics File Format:

The floor plans shall be configured in AutoCAD, JPEG or Bitmaps.

1.1.50.2. Programming:

The system software shall be able to import floor plans produced in AutoCAD.

1.1.50.3. Operation:

Upon activation of a selected input or door alarm the map shall pop-up and display the alarmed device with an alarmed icon. The operator shall be able to click on the map and clear the alarm or control the device from the graphical interface. Mapping shall be realtime and interactive.

1.1.51. Video Badging

1.1.51.1. The system shall have the capability to permit Video Imaging and Badging, which shall, when used in conjunction with the system software, function as an integrated Video Imaging/Badging and access control system. The system shall utilize a single PC to input data for both access and video Badging. The system shall not require the operator to enter data more than once. Badge information including name, card/tag number, signature, fingerprint, user text, bar coding and up to five data fields shall be available for each card/tag. The system shall provide for user definable backgrounds. These backgrounds may be a "captured" image or a colour background. The system shall be capable of supporting Windows ® 2000/XPPRO/WIN7PRO compliant video printers.

1.1.51.2. Badges may be created in both horizontal and vertical configurations. In order to change a card/tagholder's badge, a new background may be selected from the background table. A new picture capture is not required. The system shall allow any input or reader to be programmed such that an event at that location is captured by a remote camera and displayed while being stored in the database for later viewing or printing. Events at the reader shall display in real time and store a "split screen" showing the stored card/tagholder image next to the "captured" image. Camera control shall be accomplished via an RS232 interface from the system to a video switcher. The programming of the camera switcher for the individual inputs and readers shall not require exiting from the access control program.

1.1.51.3. Additional Badging and/or alarm PC stations may be added via a local area network (LAN).

1.1.52. Video Imaging

1.1.52.1. The system shall have the capability to import images of employees and store them in the database. These images may be recalled and displayed by the operator.

- The system shall have the ability to capture pictures and save from IP Video Cameras.

- The system shall provide for the backing up and restoral of captured pictures.

1.1.53. DVR and NVR Integration

- 1.1.53.1. The system shall be able to integrate seamlessly via TCP/IP to multiple manufacturers DVR's and NVR's simultaneously. The operator shall have the option to associate any camera with a device and through a common video window, control, and operate any device with real time viewing. Video shall be accessible from any device via a right mouse click.
- 1.1.53.2. Video history of any event shall be accessible via a right mouse click.
- 1.1.53.3. The video window shall automatically pop-up upon activation of the associated device's alarm. Video shall be common to all manufacturers systems so that the operator only sees one view.
- 1.1.53.4. Non-proprietary servers shall be used with provision for fail-over and redundancy.
- 1.1.53.5. VMS shall be available in multiple languages including French.
- 1.1.53.6. The VMS (video management software) shall be compatible to ONVIF compliant cameras and many other IP cameras.

1.1.54. Interactive Guard tour:

The system shall incorporate an interactive guard tour module to provide real time status of the Guards progression. Failure to complete a tour shall activate alarms on site and off-site for life safety operations.

1.1.55. Asset Management:

The system shall incorporate an asset management module so that owners are assigned to equipment or vehicles to prevent theft. Upon alarm the system shall notify via alarm, CCTV interface, and email status the improper event.

1.1.56. System Tools

- 1.1.56.1. Copy Wizard -The system shall provide a copy wizard to quickly copy any device parameter to any other single or group of devices.
- 1.1.56.2. Back-up Scheduler- The system shall have a backup scheduler for automatic backup of data
- 1.1.56.3. Custom Cardholder fields - The system shall have the ability to custom design the cardholder data by adding new fields at will.

1.1.57. Biometric/Fingerprint Enrollment

The software shall have an integrated tab in the cardholder screen to enable the operator to enroll fingerprints/ biometrics directly from the software. Programs that open third party software are unacceptable.

Hardware - AxiomV Controller Panels

UNC500 TCP/IP CONTROLLER

- 1.2. The controller panel shall be a 32 bit microprocessor controlled solid-state electronic device and shall include a real time clock/calendar on board. Boards shall be made of gold plated construction (Copper or leaded will not be accepted) and incorporate flashware technology. Communication shall Two channel TCP/IP standard LAN/WAN windows environment protocol. A subset of the system database sufficient to support access and alarm functions for its designated readers and points shall be stored at the controller panel. In event of communication loss, the controller panel shall continue to function without degradation of operation and shall provide storage of a least 10,000 events. These stored events shall be uploaded to the CPU automatically upon restoration of the communications. The system shall be capable of performing all system functions indefinitely without the computer.
- 1.3. The controller must be FCC, CE, RoHS and UL listed.
- 1.4. The controller must have 8mb Ram available on board
- 1.5. The controller must have 65,000 offline event buffer
- 1.6. The controller must have 3 programmable RS485 ports
- 1.7. The controller must have 2 on board Wiegand reader ports to accept any Wiegand format and 5 Wiegand formats simultaneously.
- 1.8. The controller must have 8 fully supervised inputs capable of individual configuration for EOL (single and dual EOL), N.O, N.C. operation.
- 1.9. The controller must have 8 outputs. 4-form 'C' relay outputs rated at 10A-30VDC and 4-open collector 100ma outputs.
- 1.10. The controller must have two on board TCP/IP LAN connections capable of configuration in LAN switch mode or dual LAN operation for Class 'A' Communication configurations.
- 1.11. The Controller must have separate tamper input
- 1.12. Input voltage 12vdc or 30w P.O.E. maximum current draw 500ma
- 1.13. The controller must have internal charging circuit for 12vdc gel cell standby battery. The controller shall be capable of recharging a standby battery from either P.O.E. source or 12v local power supply.
- 1.14. The controller shall be configurable in the following methods. Edge device, Wall mount controller or Rackmount.

- 1.15. Edge device deployment shall be POE and operate continuously even if POE is lost. Edge controller shall operate 1 or 2 doors as desired.
- 1.16. Rackmount configuration shall be 2 UNC500 controllers or 4 doors in a standard 1U-19inch rack configuration. LAN connections shall be front facing as standard Network configuration. All device connections shall be independent and removable from the rear of rack for quick disconnect and easy troubleshooting. All rackmount cabinets shall have optional rails for slide out configuration. All rackmount cabinets shall have top removable panel to access control panels.
- 1.17. The controller when configured in switch mode shall allow LAN looping from one standard windows device to another as any standard network switch allows without the use of external switches or special LAN cabling.
- 1.18. The controller must accept and control up to 7 slave reader controllers and 16 I/O controllers simultaneously.
- 1.19. Links are defined as any action causing any reaction on the system. Each controller shall be capable of initiating 'Links' regardless of the computer status.
- 1.20. Readers shall have the ability to initiate s swipe and or 4 swipe commands based on user card programming to initiate a different sequence of events depending on the need.
- 1.21. The controller panel shall be capable of storing up to eight (25) custom card/tagcard/tag/tag formats and reading 5 formats simultaneously. The controller panel shall be able to read the format of most Magnetic Stripe, Bar Code, Proximity or Wiegand Effect encoded card/tagcard/tag/tags and shall allow an operator to specify parity, start sentinels, stop sentinels, field separators, facility code bits, issue level bits, and card/tagcard/tag/tag number bits.
- 1.22. The controller panel shall be capable of reading card/tag numbers up to eighteen (18) digits.
- 1.23. The controller panel shall have the capacity to store up to 128 time zones with each time zone consisting of up to 16 intervals of time. Each interval of time shall consist of a range of days (seven days of the week, in addition to a Holiday Schedule) as well as a range of time. The controller panel shall automatically manage time zones based upon its internal clock.
- 1.24. The controller panel shall allow for the definition of up to 365 Holidays. Holidays shall be defined according to day of year and time of day. All holidays shall be automatically incorporated into Time Zone definitions.
- 1.25. Each card/tag reader/keypad shall have the ability to independently operate in up to six different modes: Card/tag reader only, PIN only, Common Code only, Card/tag Reader plus PIN, High Security and Free Access. These modes of operation shall be programmed from the system host computer and shall automatically change by time zone assignment.
- 1.26. The system shall support interlock groups for Man –trap operation.

- 1.27. The controller panel shall allow for the support of anti-passback operation, in which card/tagholders must follow a proper in/out sequence.

UNC100 CONTROLLER

- 1.28. The controller panel shall be a 32 bit microprocessor controlled solid-state electronic device and shall include a real time clock/calendar on board. Boards shall be made of gold-plated construction (Copper or leaded will not be accepted) and incorporate flashware technology. Communication shall One channel TCP/IP standard LAN/WAN windows environment protocol. A subset of the system database sufficient to support access and alarm functions for its designated readers and points shall be stored at the controller panel. In event of communication loss, the controller panel shall continue to function without degradation of operation and shall provide storage of a least 10,000 events. These stored events shall be uploaded to the CPU automatically upon restoration of the communications. The system shall be capable of performing all system functions indefinitely without the computer.
- 1.29. The controller must be FCC, CE, RoHS and UL listed.
- 1.30. The controller must have 2mb Ram available on board
- 1.31. The controller must have 50,000 offline event buffer
- 1.32. The controller must have 1 programmable RS485 ports
- 1.33. The controller must have 2 on board Wiegand reader ports to accept any Wiegand format and 5 Wiegand formats simultaneously.
- 1.34. The controller must have 4 fully supervised inputs capable of individual configuration for EOL (single and dual EOL), N.O, N.C. operation.
- 1.35. The controller must have 4 outputs. 2-form 'C' relay outputs rated at 10A-30VDC and 2-open collector 100ma outputs.
- 1.36. The Controller must have separate tamper input
- 1.37. Input voltage 12vdc or 30w P.O.E. maximum current draw 500ma
- 1.38. The controller must have internal charging circuit for 12vdc gel cell standby battery. The controller shall be capable of recharging a standby battery from either P.O.E. source or 12v local power supply.
- 1.39. The controller shall be configurable in the following methods. Edge device, Wall mount controller.
- 1.40. Edge device deployment shall be POE and operate continuously even if POE is lost. Edge controller shall operate 1 or 2 doors as desired.

- 1.41. The controller must accept and control up to 7 slave reader controllers and 16 I/O controllers simultaneously.

RBH-IOC-16 Input Output Controller

- 1.42. Additional inputs and outputs shall be available by adding IO boards. Each expansion board shall have a minimum of sixteen (16) supervised inputs or outputs. The inputs shall incorporate full supervision of 7 circuit types and the outputs shall be form "C". Up to sixteen (16) expansion boards shall be available for each controller panel.
- 1.43. The IO board shall be independently powered and have its own back up power supply and charging circuit for a minimum 4 hour standby operation.

RBH- ENCL2 Wall Cabinets

- 1.44. The controller panel enclosure shall have a hinged cover with key lock. A control panel input point shall monitor an enclosure tamper switch.
- 1.45. The cabinet shall be 22" X 18" X 4" with ½ and ¾ inch knockouts. The back of the cabinet shall have key mounts for easy mounting.
- 1.46. The cabinet shall hold any two of the following controllers UNC500, NC100, RC2, IOC16

NC100 Controller Panel Firmware Features

- 1.47. The controller panel shall have the ability to store up to 7000 card/tagcard/tag/tag/pin codes expandable to 500,000 and buffer up to 10,000 transactions expandable to 500,000.

CARD/TAG READERS & CARD/TAGS

- 1.48. The system shall employ a proximity access control/identification technology that utilizes radio frequency (RF) circuits in microchip form. The microchips are encoded and transmit the encoded information when activated.
- 1.49. The readers shall be any weigand output or equivalent proximity/iclass/mifare type. It shall read the identification number of the card/tag or tag when presented to the surface of the reader without physical contact.
- 1.50. Single piece window/door frame reader, which shall mount directly on a standard 1.75" (4.5cm) metal mullion/door frame. The reader can be mounted indoors or outdoors on virtually any surface, including metal. The reader shall operate between 5 volts and 14 volts DC to allow for ease and flexibility in installation. Read range with a standard proximity card/tag shall be up to 4" (up to 10cm) when installed according to manufacturer's specifications. Maximum dimensions of the reader shall be 5.5" (14.0cm) High x 1.6" (4.1cm) Wide x 0.75" (1.9cm) Thick.
- 1.51. A single piece wall switch reader, which shall mount directly on a standard metal or plastic single-gang electrical box, or on a flat wall or metal surface, and shall operate indoors or outdoors. The reader shall operate between 5 volts and 14 volts DC to allow for ease and

flexibility in installation. Read range with a standard proximity card/tag shall be up to 4" (10cm) when installed according to the manufacturer's specifications. Maximum dimensions of the reader shall be 4.6" (11.7cm) High x 2.9" (7.6cm) wide x 0.5" (1.3cm) Thick.

- 1.52. A single piece reader, which shall mount to any surface, including metal, or can be concealed behind most building materials, except metal. Read range with a standard proximity card/tag shall be up to 7" (17cm) when installed according to manufacturer's specifications. Maximum dimensions of the reader shall be 4.6" (11.7cm) High x 5.5" (14cm) Wide x 1.4" (3.6cm) Thick.
- 1.53. A medium range reader, which shall mount to most surfaces, except directly on metal, or can be concealed behind most building materials, except metal. Read range with a standard proximity card/tag shall be up to 21" (42cm) when installed according to manufacturer's specifications. Maximum dimensions of the reader head shall be 8.8" (22.4cm) High x 8.8" (22.4cm) Wide x 1.14" (2.9cm) Thick.
- 1.54. The card/tag or tag shall be read when presented in any orientation or at any angle to the surface of the reader within the proper read range
- 1.55. The reader shall power the card/tag or tag, process the encoded data, and output the data to the access system in less than 110 milliseconds.
- 1.56. There shall be no removable plate or cover, which allows access to the reader electronics.
- 1.57. A red/green LED on the front surface of the reader shall indicate to the user that the card/tag or tag was read (internal/reader controlled) and an access decision was made (system controlled). The LED may be configured in either single line mode or dual line mode (allowing an "off" state) as required by the host system, and the reader may be switched between modes by presenting a programming card/tag to the face of the reader.
- 1.58. The reader shall have an audio "beep" tone feature to indicate to the user that the card/tag or tag was read (internal/reader controlled) and an access decision was made (system controlled). The audio tone must be independently controllable and not tied to the status or colour of the LED. The internal control of the LED and beeper may be enabled/disabled via programming card/tags so as not to require the setting of switches internal to the reader.
- 1.59. The reader shall have a built-in diagnostics, which indicate to the installer that upon power up the reader has performed an internal test and is functioning properly.
- 1.60. The reader shall have a built-in diagnostic feature, which allows a single technician to test the continuity of the data lines independent of the door controller. The reader may be placed into the line diagnostic mode via a programming card/tag, and the technician can then measure the pulses at the end of the line without the need of a second technician at the reader presenting card/tags.
- 1.61. Electrical connections between the reader and the controller shall be via colour coded, multiconductor; #22 AWG shielded cable. No coaxial cable or special connectors shall be required. The output shall be in the form of Wiegand data stream.

- 1.62. Wiring from the reader assembly to the system interface or CPU shall be run inside metal conduit or EMT, as may be required by electrical codes. All junction boxes are to be concealed and not normally accessible to the public. Utilization of PVC conduit is not acceptable.
- 1.63. Accidental or intentional transmission of radio frequency signals into the reader shall not compromise the system.
- 1.64. The reader shall function in the access control system's normal or anti-passback mode without changes to the reader.
- 1.65. The reader operating temperature range shall be -40° to +50° C
- 1.66. Damage or vandalism to the reader shall not damage any other part of the system.
- 1.67. Tampering with the reader shall have no effect on the door security.
- 1.68. The system readers shall have the capability to accept codes from any of the following proximity devices:
 - 1.69. A standard molded plastic credit card/tag sized card/tag having maximum dimensions of 3.41" (8.7cm) x 2.14" (5.4cm) x 0.09" (0.23cm), and a weight of not more than 0.48 oz. (13.5g). A punched slot shall be provided for a strap or clip. The card/tag shall be capable of having multi-colour custom graphics and permanently marked numbers printed directly onto both sides.
 - 1.70. A tag having maximum dimensions of 2.2" (5.6cm) x 1.3" (3.3cm) x 0.25" (0.6cm), and weight of 0.36 oz. (9.9g). A brass eyelet shall be provided for attachment to a key ring.
 - 1.71. A credit card/tag sized card/tag made of PVC, having maximum thickness of .036", and the capability of accepting direct print video imaged graphics and photographs and able to carry a high coercivity magnetic stripe.
 - 1.72. A credit card/tag sized card/tag having maximum thickness of .048", and capable of accepting a photograph and graphics via a customer laminated flap.
 - 1.73. The card/tag shall be a polycarbonate-based card/tag that cannot be run through direct card/tag printers. The card/tag shall be a PVC dual technology card/tag that employs proximity sensor technology. It shall comply with ISO standards for thickness (30 mil).
 - 1.74. The card/tag or tag shall be made of robust ABS plastic to provide maximum protection for the circuitry inside and provide minimal flexing which could cause damage to the card/tag.
 - 1.75. The presence of small metal objects, such as keys or coins near the card/tag or tag shall not alter the code read by the reader, nor prevent the code from being read by the reader.
 - 1.76. The card/tag shall be of a proprietary format to be controlled by the Owner.
 - 1.77. Card/tags or tags shall be sequentially numbered. The user may specify codes or numbers.

- 1.78. The card/tag must have the ability to have the encoded number permanently marked on the outside surface.
- 1.79. The card/tag or tag shall be a passive device with no internal battery, but shall contain a semiconductor element, which is energized when brought within the operating range of the reader causing transmission of the code from the card/tag or tag to the reader. Card/tags requiring an internal battery or energy cell shall not be acceptable.
- 1.80. Card/tags and tags may be used interchangeably and shall be compatible with all readers in the system, regardless of the reader's physical size or style, and without any code matching or memory devices in the reader.
- 1.81. The card/tag and tag operating temperature range shall be -40° to +50° C

2. Fingerprint/Biometric Readers and Software Integration

- 2.1. The fingerprint reader shall be RBH-BFR.
- 2.2. The software shall have an integrated tab in the cardholder screen to enable the operator to enroll fingerprints/ biometrics directly from the software. Programs that open third party software are unacceptable.
- 2.3. The capture template will allow the capture of a primary and secondary finger as a backup.
- 2.4. The authentication will be automatically downloaded to the reader upon successful capture of the fingerprint without intervention by the operator. The download shall be by TCP/IP communications to the fingerprint readers.
- 2.5. The fingerprint must be saved as an algorithm to protect individual privacy.
- 2.6. The fingerprint algorithm shall be saved within the normal AxiomV database for automatic backup and restore capabilities. External backup systems for fingerprint are not acceptable.
- 2.7. The fingerprint reader shall be configurable to operate in any of the following modes. Finger only, Card only, card plus finger, Finger plus PIN code, Finger or Card.
- 2.8. The reader shall have a Wiegand output to connect to the door control panel

3. ACS VMS INTEGRATION

- 3.1. Integration must be through TCP/IP (relay and or RS232 connections are not acceptable).
- 3.2. All devices within the ACS system must have a tab to associate a video camera from the VMS system to the device. This association must allow the camera to be called into the ACS GUI upon the following conditions. A) Any Incoming event from specified device B) Any incoming alarm from the specified device. The camera if PTZ must also be called to its predesignation preposition.
- 3.3. The ACS must be able to connect to the VMS system and display the VMS's default video window as a native VMS viewing client.

- 3.4. The ACS must have the ability to pop-up any video event designated for pop-up without operator intervention.
- 3.5. The ACS must have the ability to manually call video by clicking on the event anywhere it appears in the ACS.
- 3.6. The ACS must have the ability to dynamically place the cameras from the VMS system on its maps and call video from the maps directly.
- 3.7. The ACS must have the ability to report all events tagged with video and play back directly from the report within the ACS GUI.

ALARM KEYPADS

The system shall incorporate alarm keypads that link directly to the system for advanced alarm operation. Operators can arm, disarm, send messages and monitor any alarm on the keypad. In addition the keypads shall have entry exit zones and the ability to initiate commands on the system by entering a code or command. The keypads will have the ability to arm or disarm any group of inputs on the system creating a seamless alarm intrusion panel.

ALARM MONITORING INTEGRATION

- 3.8. The system shall allow for annunciation of intrusion detection alarms. Intrusion detection alarms shall report just like any other access control alarm and shall have the same annunciation and display properties as access control alarms.
- 3.9. Alarms from the alarm keypad shall be displayed in the alarm monitoring window and any signal can be sent out via TCP/IP or message port.
- 3.10. The system shall support an Alarm Details description that shall show the 'Alarm Description', 'Time/date', 'Controller', 'Device', and 'Area' associated with the alarm. The information shall also display the user.
- 3.11. The system shall support tracing of intrusion detection devices and areas.
- 3.12. The system shall be able to report status information for the intrusion detection devices.
- 3.13. On alarm, the system shall automatically switch to the map that displays the alarm, the icon that represents that alarm point will flash and an audible alert will be generated on the computer sound system. The operator shall have to acknowledge the alarm before processing the alarm.
- 3.14. In operator alarm mode processing, the system shall allow the operator to:
 - 3.14.1. clear alarm, tamper, and diagnostic alarms

- 3.14.2. observe CCTV camera views, individually or in groups, that are associated with an alarm (requires video switcher option)
- 3.15. In operator normal mode processing, the system shall allow an operator to:
 - 3.15.1. view a list of activity information, and select and tag any event
 - 3.15.2. view site maps
 - 3.15.3. perform a test of testable devices/sensors
 - 3.15.4. change the state of sensors to access or secure
 - 3.15.5. review the last 1000 events/actions performed on the system
- 3.16. In maintenance processing, the system shall allow the maintenance technician to:
 - 3.16.1. assign passwords and function access to individual users
 - 3.16.2. examine the input/output point states
 - 3.16.3. adjust the sensitivity of the sensors
 - 3.16.4. access the operating system to diagnose system problems
 - 3.16.5. set the calendar clock's date and time (in Windows)
 - 3.16.6. change the format of the displayed date (in Windows)
 - 3.16.7. set the communication parameters for system devices
 - 3.16.8. shut down the system

WIRELESS LOCKSET INTEGRATION

The system shall support the integration of SALTO SALLIS wireless locksets with the security management system.

The wireless system and components shall offer as a minimum:

- 3.17. Wireless Radio Frequency based on IEEE 802.15.4 at 2.4 GHz.
- 3.18. Wireless communication shall incorporate AES 128bits encryption.
- 3.19. Reading time shall be less than 150 milliseconds.
- 3.20. Card reader ID technologies for the locks shall be able to read one of these: Mifare, Mifare plus, DESfire, DESfire EV1, HID iClass.

- 3.21. Powering by standard non-proprietary, commercially available batteries. Renewal of batteries shall only be permissible from the secure side of any door with access to the battery compartment only achievable by the use of non-commercially available tool sets provided exclusively by the manufacturer.
- 3.22. All electronic locking devices must be able to be temporarily activated by an appropriate device in the event of total battery failure.
- 3.23. The access control system shall have a comprehensive battery management reporting system to allow for the viewing of the battery status of any locking device in the system at any time.
- 3.24. The locking devices themselves shall provide, upon activation by a credential or other means, a distinguishable and audible signal when any battery is reduced to its last 1,000 usable cycles.
- 3.25. The system shall support more than 500 remote locksets; each UNC100 controller configuration shall be rated for the number of locksets it can support.
- 3.26. Once a lockset is installed and registered with the controller, it shall appear in the AxiomV software as a traditional access point, which can be enabled and configured to work with the controller.
- 3.27. When a wireless lockset is networked to the AxiomV software, the operator shall be able to lock or unlock in real-time, the lock, under 2 seconds.
- 3.28. All locksets connected to the AxiomV software shall be treated as an online lockset and assigned the Default (Online) lockset profile.
- 3.29. Locksets can be assigned to locations.
- 3.30. Locksets shall be added and managed in floorplans.
- 3.31. Locksets can be unlocked momentarily via event actions or from the AxiomV client, the AxiomV mobile app, the Monitoring Desktop, or a floorplan within one minute.
- 3.32. Activity associated with a lockset shall be viewed in real time in the Activity Log.

Installation

- 3.33. The contractor shall install all system components in accordance with the manufacturer's instructions, and shall furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified and shown. Power, control, signal and communications, and data transmission lines plus all required grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. Provide mounting hardware as required.
- 3.34. All products, software, programming tools, etc. shall be registered to The Owner and will be surrendered upon successful completion of the project.

- 3.35. All low voltage wiring outside the control console, cabinets, boxes, and similar enclosures, shall be plenum rated where required by code. Cable shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring.
- 3.36. All inputs shall be protected against surges induced on device wiring. Outputs shall be protected against surges induced on control and device wiring installed outdoors. All communications equipment shall be protected against surges induced on any communications circuit. All cables and conductors, except fibre optics, which serve as communications circuits from security console to field equipment, and between field equipment, shall have surge protection circuits installed at each end.
- 3.37. No wiring or cabling shall be exposed; all wiring and cabling must be fully enclosed in threaded metallic conduit, which shall be installed underground, in walls or metal structures unless physically impossible. Any conduit that is exposed shall be fully enclosed within an expanded metal protective cage that is vandal resistant and is equipped with a tamper alarm. All equipment mounting is to be such that the equipment cannot be removed or tampered.

CARD READERS

The access control shall only utilize readers supplied HID Global. The readers will support multi card formats and be available in multiple form factors and transmit power ratings.

- 4.1 Support for iClass, iClass Seos, MIFARE Classic, MIFARE DESFIRE EV1 @ 13.56 MHz transmit frequency.
- 4.2 Support for HID Prox, Indala Prox, EM4102 Prox at 125 KHz transmit frequency.
- 4.3 Support an operating voltage range of 5-16 VDC.
- 4.4 Support OSDP SC over RS485 for panel communications and reader firmware updates.
- 4.5 Support an operating temperature range -35° C to +65° C.
- 4.6 Support a storage temperature range of -35° C to +65° C.
- 4.7 Support an operating humidity range of 5% to 95% relative humidity.
- 4.8 Carry an IEEE IP55 rating, IP65 with optional gasket, part #IP65GSKT.
- 4.9 Carry the following industry certifications: UL294/cUL and Industry Canada.
- 4.10 Carry a limited lifetime warranty.

END OF SECTION

28 23 00 Video Surveillance

VMS Applications

The enterprise VMS software installed at City of XXXX sites are to be manufactured by March Networks. The system integrator providing the equipment will ensure that all units are in compliance with the general requirements listed in section 2.4 of this document.

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Command Enterprise Server Software

1.2 RELATED SECTIONS

- A. Section 26 05 00 - Common Work Results for Electrical
- B. Section 27 11 23 - Communications Cable Management and Ladder Rack

1.3 REFERENCES

- A. Canadian ICES-003.
- B. Consultative Committee for International Radio (CCIR).
- C. Conformity for Europe (CE).
- D. Electronic Industry Association (EIA).
- E. Federal Communications Commission (FCC).
- F. Joint Photographic Experts Group (JPEG).
- G. National Television Systems Committee (NTSC).
- H. Phase Alternating Line (PAL).
- I. Underwriters Laboratories Inc. (UL).

1.4 DEFINITIONS

- A. HD (High-definition) - refers to video having resolution substantially higher than traditional television systems. HD has one or two million pixels per frame.
- B. CIF (Common Intermediate Format) - refers to a standard video format, which is categorized based on the resolution.

1.5 SUBMITTALS

- A. Manufacturer's Product Data: Submit manufacturer's data sheets indicating systems and

components proposed for use, including instruction manuals.

- B. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, customized to the system installed. Include system and operator manuals.

1.6 QUALITY ASSURANCE

- A. Manufacturer shall provide customer service, pre-sales applications assistance, after-sales technical assistance, access to online technical support, and online training using Web conferencing.
- B. Manufacturer shall provide 24/7 technical assistance and support by means of a toll-free telephone number at no extra charge.
- C. Installer: Minimum two years' experience installing similar systems, and acceptable to the manufacturer of the video management system.
- D. Power Requirements: Components shall have the following electrical specifications: 100-240 V AC (50 Hz/60 Hz) or as specified for individual products within part 2 of the specification.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.
- B. Handling: Handle materials to avoid damage.

1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.9 SEQUENCING

- A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

PART 2 PRODUCT

2.1 MANUFACTURER

Acceptable Manufacturer: March Networks, which is located at: 303 Terry Fox Drive, Suite 200; Ottawa, Ontario, Canada K2K 3J1; Toll Free Tel: 800-563-5564; Email:sales@marchnetworks.com; Web:www.marchnetworks.com

2.2 COMMAND ENTERPRISE SERVER SOFTWARE

- A. System Software Characteristics

1. The Enterprise server software shall run on a stand-alone or virtualized server, separate from any recording server software.
2. The Enterprise server software database server shall contain a database of all network-connected recorders, recording servers, edge devices and their configurations. The database shall contain details including:
 - i. System configuration
 - ii. Camera configuration and settings
 - iii. Recorder configuration and settings
 - iv. System users
 - v. Health parameters
 - vi. Alarm parameters
3. An Enterprise server software database shall be included with the primary installation package and shall not require the customer to install a separate installation of the database.
4. The Enterprise server software database shall be independent to allow customers to install their system on their existing SQL database environment within the limitations of the Enterprise System Software supported database characteristics.
5. The system independence shall allow host/storage platforms to be supplied optionally by the Enterprise software manufacturer, the system integrator or the customer IT.
6. The Enterprise server software shall support enterprise grade virtualization.

B. Network Communications

The Enterprise solution shall have robust IP networking features, in line with IT management team expectations. These features shall include the following:

1. Servers running the Enterprise software shall connect to an enterprise LAN or WAN network via a Gigabit Ethernet connection. The client viewing and configuration applications shall operate on workstations connected (locally or remotely) to the LAN/WAN using network connections to support the number of desired cameras viewed per workstation, and shall communicate with the VMS across this network. The Enterprise system host server(s) and client applications shall communicate using the TCP/IP protocol.
2. The Enterprise Server software shall operate using either DHCP or static IP addressing. If using DHCP addressing, client software must be able to connect to an Enterprise server using its new address without any action on the part of the user.
3. The Enterprise solution shall operate using a peer-to-peer architecture with no central video-streaming server and there shall be no imposed limit to the scalability of the system.
4. The Enterprise Server software shall require HTTP and HTTPS connections for communications.

C. Enterprise Server Software

At the core of the IP video solution, the Enterprise Server software shall have the following characteristics:

1. The Enterprise server software shall be host-hardware-independent and be purpose-built for the system management.
2. The Enterprise server software shall be compatible with any of Windows® Server 2012 and 2012 R2, Windows® Server 2016 and Windows® Server 2019 operating systems.
3. The Enterprise server software shall support LDAP/Microsoft Active Directory for user authentication.
4. The Enterprise server software shall not reside on the same server as the LDAP/Microsoft Active Directory Server component.
5. The Enterprise server software shall run Oracle Glassfish Enterprise Server.
6. The Enterprise server software shall run a SQL database engine from a top manufacturer such as Microsoft, Oracle or others.

D. General

The primary client software shall support an integrated license management, user management and system health monitoring applet with the following characteristics:

1. This shall be an enterprise-class central management utility, addressing all related software license management and user access privileges management. It shall also provide comprehensive, real-time system health maintenance functions. These capabilities shall extend seamlessly across any number of video installations and any number of network-linked physical locations. All local and remote management functions shall operate over a TCP/IP LAN or WAN network.
2. This utility shall consist of the user interface within the client interface and a necessary server-based software engine. Together these software components shall provide the management functionality described in this Section.

E. Licensing

The Enterprise server software manufacturer shall license the software per manufactures Hybrid/NVR recorders on a per video channel basis for manufacturers VMS recorders, in such a way that there are no license fees associated with client applications, site installation, user accounts, basic add-on features or other license fees. The licensing program characteristics are:

1. The enterprise system shall have an enterprise base license that allows access to all basic features and functionalities without any additional licenses except camera licenses.
2. Edge device license shall not be tied to a hardware address (MAC Address).
3. The Enterprise Server software shall not be tied to the server hardware.
4. Camera licenses may be moved between recording servers.
5. All camera licenses are moveable without requiring manufacturer action of any type.

6. The enterprise system shall include 10,000 recorder connection licenses.
7. All embedded recorder licenses include all channels of video associated with the recorder whether the unit is a 4, 8, 12, 16, 24, 32, 48, or 64 channel unit. No additional edge device licenses are needed when a recorder has a valid connection license.
8. Each VMS recorder server shall be capable of supporting 128 edge device connection licenses.
9. All basic VMS client software shall be included in the base VMS software cost.
10. The client application can be used on an unlimited number of times and may be running simultaneously without any additional licenses.
11. The enterprise system software base license shall be capable of supporting 10,000 recording servers/recorders licenses and/or 128,000 edge device connection licenses.
12. The enterprise system shall support the ability to license additional components such as third party access control integration plugins, video or sensor analytic channels, and other manufacturer's applications that sit on top of the enterprise system.

F. Administration Functionality

The client shall provide the user interface for the licensing, user management and system health management activities introduced above. It shall be accessed by authorized users from within the primary client application and its features and functions shall include but not be limited to the following:

1. Software License Keys shall be the technology used to officially enable Enterprise capacities and capabilities, including enterprise server licenses, edge device connections, NVR connections, DVR connections, enhanced applications, etc. The client shall provide the mechanism for entering, activating, updating and tracking the status of all related licenses in a single or multi-server environment.
2. The software shall provide enhanced user access control, including matching authorized system administrators to individual or groups of recording servers/recorders and allowing them to review, modify and update programming remotely.
3. The software shall be used to manage access privileges for all other system users as well. Authorized Administrators shall be able to define user names, passwords and access rights, as well as logical groupings recording servers, recorders, views, and individual users. Users shall be assigned to groups which have defined privileges, and these groups shall be assigned access to the appropriate system resources.
4. Privilege management shall provide a specific level of granularity, allowing access to be controlled down to logical groups of resources including cameras, recorders, views, maps, and logical folders.
5. The client shall include a complete set of features for monitoring the health of the complete video surveillance infrastructure, including all local and remote recorders/recording servers, storage devices and hard drives, IP cameras, encoders and any other solution elements.

6. Health alert triggers shall include but not be limited to failed network connections, unit performance problems, camera synchronization loss, recording server temperature exceptions, and more for select recording solutions.
7. Health alert triggers shall support thresholds to limit the number of alerts visualized and stored by the enterprise system. Thresholds shall support the ability to filter issues by number of occurrences per type, number of occurrences in time, and a combination of the above.
8. The Enterprise system shall automatically and without user intervention provide a process whereby critical system events including alarms shall be visually brought to the attention of the user.
9. The Enterprise system shall visually notify the user if a server becomes unreachable during a session.
10. The Enterprise system client shall be capable of monitoring a recording servers/recorders and reporting the following items:
 - a. Installed recording software version.
 - b. Total amount of system memory.
 - c. Total amount of available system memory.
 - d. Total CPU utilization.
 - e. Video source status including current recording status.
 - f. Provide a list of events that have occurred on the selected server since the initial connection.
11. Listing of currently connected clients including connection number, client (source) IP address, description of the client and the username used by the selected client
12. The Enterprise system shall support “single seat administration” so that a single management application administers multi-server/multi-client environments. This allows simultaneous control of multiple servers and clients and system-wide monitoring of the health and status of all recording servers/recorders and cameras from one console. Support is included for:
 - a. Push-based, secure, distribution of application configuration for all VMS recording server software components where the update process occurs in parallel for all selected servers.
 - b. Pull-based configuration updates of recorders/recording servers, and edge devices.
 - c. Support for remote configuration of all VMS recording server/hybrid servers in the enterprise network.
 - d. Support for remote monitoring of all VMS recorder/recording server software components.
 - e. Manage recorder and device licenses centrally
 - f. Centrally configure users
 - g. Centrally configure logical folders, add/remove resources from folders.
 - h. Replicate users
 - i. Replicate device configuration across like kind device types and recorders.

G. Resource Detection and Configuration

1. The Enterprise Server software shall have the ability to register/unregister physical recording server, hybrid NVR and NVR recorders.
2. The Enterprise Server software shall offer the ability to auto-discovery all recording servers and hybrid network video recorders in the Enterprise Server LAN and associated edge devices in the managed video surveillance network.
3. The Enterprise Server shall be able to initiate a proxy session to any IP edge device with a recorder. The Enterprise Server client shall be able to launch a session with the cameras page if the platform allows it.

H. Mass Management

1. The server software shall host the database for maintaining select manufacturer's edge device configurations and firmware status.
2. The server software shall support secure connections, registration, and the ability to send configuration changes to recording servers and hybrid network video recorders.
3. The server software shall support the ability to import device configurations and have the ability to send device configuration upon request.
4. The server software shall support the ability to import a devices full configuration, and export the full configuration to one or many manufacturer's edge devices on the network.
5. The server software shall have the ability to import/export the manufacturer's edge devices configuration details including:
 - a. Frame rate
 - b. Resolution
 - c. Compression algorithm
6. The server software shall have the ability to accept current configurations from select edge devices from IP cameras and encoders developed by the manufacturer.
7. The server software shall allow for mass configuration of recorders, recording servers, and edge devices. This shall include the ability to do the following:
 - a. Copy Configuration
 - b. Apply Configuration
 - c. Monitor Configuration
 - d. Associate Configuration
 - e. Update Configuration

I. Firmware Management

1. The server software shall allow the ability to apply firmware from the enterprise server to one or many edge devices manufactured by the manufacturer at a single time.

2. The server software shall allow the ability to apply firmware from the enterprise server to one or many recorders manufactured by the manufacturer at a single time.
3. The server software shall allow the ability to limit the number of concurrent firmware updates and the total recorders incoming bandwidth and enterprise system outgoing bandwidth used for the updates.
4. The server software shall allow the ability to store the most current device firmware on the enterprise server.
5. The enterprise server shall provide a visual notification when any one device is not current with the most current version of firmware on that is available on the enterprise server.
6. The server software shall support the ability conduct the following actions for edge devices firmware management.
 - a. Upload firmware
 - b. Apply firmware
 - c. Restore firmware

J. System Security and Reliability

The Enterprise Server software shall provide the following system-wide IT defenses and security capabilities view:

1. Each Enterprise host server shall be capable of being deployed 'behind' a standard and likely existing LAN/WAN security firewall, benefiting from the virus and malware protection software and other encryption and intrusion defenses in place on that network.
2. The Enterprise system shall minimize the number of access points attackers could attempt to exploit to gain access to the system or at which a virus or similar form of malicious software may be directed to compromise the operation of or the data associated with the system. All communication with the Enterprise system shall be tightly restricted, with most external communication ports being permanently blocked from user access (and with no way made available to open them). This includes all TCP and UDP ports not required for system operation.
3. All analog video shall be captured, digitized and transmitted over the secure network to the VMS using encoders. Analog video shall be streamed to these encoders over coaxial cables connected directly to these devices. No interception of these video streams shall be possible without physically tapping into the specific cables inside the customer premises.
4. All IP-camera video shall be captured and transmitted to the VMS over the secure network using the IP protocol.
5. The VMS shall support multiple levels of user and administrator password authentication and privileges management to control access to the system. A fully configurable matrix of user accounts, user groups and user privileges shall be supported. In an enterprise configuration, user authentication through a corporate application (i.e., Windows® Domain Server) shall also be supported via the Enterprise

server. The result shall be a single authentication functionality via this existing IT access management utility.

6. User authentication shall support the use of optional identification certificates on smart cards or USB tokens in conjunction with user credential authentication.
7. User and administrator access rights shall be fully configurable, down to the individual video resource level (i.e., to a specific camera). These rights shall apply to local and remote users equally.
8. Each VMS shall keep a running log of all user access. These logs shall be retrievable by authorized administrators, but no user shall be able to remove entries from a log. It shall be an option to copy and save a log in a text-formatted file appropriate for printing. This text file shall also be suitable for import into a third-party report management application.
9. The VMS shall contain software watchdog technology that maximizes fault-free operation. The central management application shall continuously monitor the health of the servers, edge devices, cameras and the network. It shall automatically report all problems detected per preset notification policies.
10. The Enterprise Management Software provider shall provide publicly available information on their website that lists known Security Vulnerabilities with software release versions required to address the vulnerability.

PART 3 EXECUTION

3.1 INSTALLATION

- A. All components of the video management system shall be thoroughly tested before shipping to the project location.
- B. Video management system shall be installed, programmed and tested in accordance with manufacturer's installation instructions. The integrator shall:

Coordinate interfaces with Owner's representative where appropriate.

Provide backboxes, racks, connectors, supports, conduit, cable, and wire for a complete and reliable installation. Obtain Owner's approval for exact location of all boxes, conduit, and wiring runs prior to installation.

Install conduit, cable, and wire parallel and square with building lines, including raised floors areas. Do not exceed forty percent (40 percent) fill in conduits. Gather wires and tie to create an orderly installation.

Coordinate with other trades to provide proper sequencing of installation.

3.2 FIELD COMMISSIONING

- A. Test video management system as recommended by manufacturer, including the following:

1. Conduct complete inspection and testing of equipment, including verification of operation with connected equipment.
2. Test devices and demonstrate operational features for Owner's representative and authorities having jurisdiction, as applicable.
3. Correct deficiencies until satisfactory results are obtained.
4. Submit written copies of test results.

3.4 TRAINING AND CERTIFICATION

- A. The Enterprise Management software manufacturer shall offer free online training for authorized dealer technicians through user controlled portal access.
- B. Training material shall cover all aspects of installation, configuration and maintenance.
- C. The dealer shall receive a certificate upon the successful completion of the certification exam. Certifications shall be valid for a period of 2 years.
- D. The Enterprise Management software manufacturer shall offer free online training tutorials for system administrators accessible 24/7 via open (non-restricted) website for an unlimited number of system users. The training tutorial shall cover the Enterprise system, User management, Health alert management and Mass Management (upgrades) of all registered devices on the Enterprise Server.
- E. The Enterprise Management software manufacturer shall offer free online training for Guards and Investigators accessible 24/7 via open (non-restricted) website for an unlimited number of system users. The training tutorial shall cover system access, live and archive media requests, alarm inbox management, as well as extracting media from the system

END OF SECTION

Network Video Recorders

PART 1 GENERAL

The network video recorders installed at City of XXXX sites are to be manufactured by March Networks. The system integrator providing the equipment will ensure that all units are in compliance with the general requirements listed in section 2.4 of this document.

1.1 SECTION INCLUDES

- B. 8000 Series Hybrid Network Video Recorders

1.2 RELATED SECTIONS

- C. Section 26 05 00 - Common Work Results for Electrical
- D. Section 27 11 23 - Communications Cable Management and Ladder Rack

1.3 REFERENCES

- A. Canadian ICES-003.
- B. Consultative Committee for International Radio (CCIR).
- C. Conformity for Europe (CE).
- D. Electronic Industry Association (EIA).
- E. Federal Communications Commission (FCC).
- F. Joint Photographic Experts Group (JPEG).
- G. National Television Systems Committee (NTSC).
- H. Phase Alternating Line (PAL).
- I. Underwriters Laboratories Inc. (UL).
- J. Regulatory
 - a. The recorder shall have passed the following safety standards:
 - IEC60950-1 (ed.2)
 - UL 60950-1 (ed.2)
 - CSA C22.2 No.60950-1-07 (ed.2)
 - b. The recorder shall conform to the following FCC rules and regulations:

- EMC FCC 47 CFR Part 15 (Subpart 15)
 - ICES-003
 - EN55022, CISPR 22, AS/NZS CISPR 22
 - EN61000-3-2, EN 61000-3-3
 - EN50130-4, EN55024
- c. The recorder shall have the following markings indicating compliance with the regulations for sale into the countries that accept the marking:
- CE-mark
 - cULus
 - C-tick
 - WEEE

1.4 DEFINITIONS

- A. HD (High-definition) - refers to video having resolution substantially higher than traditional television systems. HD has one or two million pixels per frame.
- B. CIF (Common Intermediate Format) - refers to a standard video format, which is categorized based on the resolution.

1.5 SUBMITTALS

- A. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, customized to the system installed. Include system and operator manuals.
- B. Field Tests: Submit results of field testing of every device including date, testing personnel, retesting date (if applicable), and confirmation that every device passed field testing.

1.6 QUALITY ASSURANCE

- A. Manufacturer shall provide customer service, pre-sales applications assistance, after-sales technical assistance, access to online technical support, and online training using Web conferencing.
- C. Manufacturer shall provide 24/7 technical assistance and support by means of a toll-free telephone number at no extra charge within the terms of the warranty agreement.
- D. Installer: Minimum two years' experience installing similar systems, and acceptable to the manufacturer of the video management system.
- E. Power Requirements: Components shall have the following electrical specifications: 100-240 V AC (50 Hz/60 Hz) or as specified for individual products within part 2 of the specification.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.

- B. Handling: Handle materials to avoid damage.

1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.9 SEQUENCING

- A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.10 WARRANTY

- A. The recorder shall have a warranty of at least 3 years.
- B. Should the recorder fail during the warranty period, a replacement recorder shall be available as an advance replacement at no additional cost in order to return the end user to full functionality as quickly as possible.

PART 2 PRODUCT

2.1 MANUFACTURER

Acceptable Manufacturer: March Networks, which is located at: 303 Terry Fox Drive, Suite 200; Ottawa, Ontario, Canada K2K 3J1; Toll Free Tel: 800-563-5564; Email:sales@marchnetworks.com; Web:www.marchnetworks.com

2.2 8000 SERIES HYBRID NETWORK VIDEO RECORDERS

- A. Recorder Characteristics – Combined with visual intelligence software, the NVR unit shall have the following characteristics:
 1. The system shall be a networked device purpose built exclusively for the capture and processing of digital video and supporting audio, metadata, alarm, storage and other services. The system shall not be based on generic industry PC components and architectures.
 2. The recorder shall be part of a family of hybrid network video recorders consisting of 32, 24, 16, 8 and 4 channel variants.
 3. The 32 and 16 channel NVR platform shall have an option use docking station architecture, marrying a removable 2U-high NVR chassis (containing all system and video processing and storage components) with a fixed housing capable of mounting in a standard 19" equipment rack and accepting power, camera, network and other wiring connections.
 4. The 32-, 16-, 8- and 4-channel NVR platform shall have the option of using a rack shelf or desk top.

5. All of the NVR platforms shall also have the option of being mounted on a wall using optional wall mount kits. The 24-, 8- and 4-channel recorders shall further have an option for concealing the cabling using a tamper proof cover.
6. The NVR shall employ an embedded Linux operating system, housed in flash memory and capable of being upgraded remotely if needed, such that no system software shall be stored on hard-drive media, and the operating environment shall be more robust and immune to virus and illicit attack than other common operating systems. At the client desktop, however, all software applications shall support the latest Windows® operating environments.
7. The NVR shall provide for choice when selecting a software interface for either an integrated browser based client or a tasked based suite of installable clients.
8. Once a software interface has been selected, the NVR shall employ a common software interface regardless of the model selected. This will yield consistent user training materials, documentation and system interaction.
9. The NVR shall provide a 'hybrid' architecture, capable of supporting traditional analog cameras in the quantities shown below as well as a number of IP cameras (see below) to increase the aggregate camera support, provide high-resolution video capture in critical customer areas, and allow migration to this new camera technology according to customer need.

A. NVR Unit Configuration

The NVR unit shall be available in the following configuration common across all models:

1. The 32-, 24- and 16-channel units shall support 4 audio inputs, 2 which can support bi-directional, half-duplex input/outputs. The 8- and 4-channel units shall support 2 audio inputs, 1 which can support bi-directional, half-duplex input/outputs
2. The 32- and 16-channel units shall support 8 alarm inputs and 4 switch outputs. The 24-, 8- and 4- channel units shall support 2 alarm inputs and 1 switch outputs
3. 1 RS-232 ports,(all models), 1 RS-485,(32 and 16 channel units only) ports for integrating banking ATM/Teller transaction or retail POS transaction capture information and PTZ camera controllers, and 4 USB 2.0 (excluding 4 channel unit, which will support 2 USB 2.0 ports), (excluding 24 channel unit, which will support 3 USB 2.0 ports (1 internal)) data port for connecting keyboard, mouse, or external media for export purposes
4. 1 RJ-45 Gigabit Ethernet network connection for LAN-based system access and management
5. 1 RJ-45 Gigabit Ethernet network connection for connecting IP cameras and encoders on a network separate from the corporate LAN
6. The 24 channel unit includes 1 RJ-45 10/100 Base-T port for POS integrations and up to 24 PoE ports (RJ-45), 10/100 Base-T
7. The 32- and 16-channel units shall support up to 4 internal hard disk drives. The 24, 8-channel unit shall support up to 2 internal hard disk drives. All drives shall be high-capacity, SATA hard disk drives, supporting up to 10TB each. The 4 channel unit shall support up to 2 internal high-

capacity, SATA hard disk drives, supporting up to 5TB each. All drives shall be mounted for easy servicing.

8. 1 internal back-up battery for filtering out power fluctuations and provide controlled system shut down.
9. The 32- and 16-channel units shall support 2U-high docking-station chassis for simple mounting and servicing in a standard 19" equipment rack or a 2U-high desk top chassis if rack mounting is not required.
10. 16/8/4 BNC video inputs, dependent on model, (with software controlled loop-through capability) able to accept NTSC or PAL composite signals
11. The 24 channel unit will can be equipped with up to 24 HD analog inputs able to accept TVI, CVI or HDA signals.
12. The 32-, 16- and 8-channel units shall support 1 composite video output (NTSC or PAL) capable of displaying both analog and IP cameras in a programmable sequence.
13. The 32-, 24-, 16- and 8-channel units shall support 1 HDMI video output capable of displaying both analog and IP cameras in a high definition user interface for live display and archive searching.
14. 240 or 480 frame-per-second (FPS) aggregate video capture for the analog inputs (based on the model selected), supporting CIF and 4CIF video format [NOTE: Select only the unit necessary for the project]
15. The 24 channel unit can support 720 frame-per-second (FPS) aggregate video capture for the HD analog inputs supporting 1080P30.
16. Depending on the model selected, the total bandwidth available for IP cameras shall be shown in the table below:

32 Channel	24 Channel	16 Channel	8 Channel	4 Channel
96 Mbps	80 Mbps	48 Mbps	24 Mbps	12 Mbps

B. Configuration and Viewing Applications

The Visual Intelligence configuration and viewing applications shall be compatible with the latest version of Windows®. Each application shall be installed from a web download or USB using an automatic installation program. All applications shall have similar interfaces in order to reduce learning time and shall operate consistently across all members of the NVR product family.

The Command Enterprise configuration and viewing applications shall be compatible with the latest version of Windows® or MAC O/S. The integrated application shall be installed on the Command Enterprise server from a CD using an automatic installation program. Once installed on the Command Enterprise server, the application can be accessed by any operator on the network via a supported browser.

Concept of Operation

13. The NVR unit shall capture, digitize and compress video (using industry-standard H.264 video compression technology and multi-level encoding to further optimize transmitted and stored video) and, if desired, accompanying audio signals on all enabled inputs. Once compressed, the unit shall either distribute the compressed data to any number of authorized users requesting the data over either of the unit's network ports from one of the supported application interfaces (Command Enterprise or Visual Intelligence).
14. In parallel, the unit shall also store all compressed data to the available internal hard disk drive(s). These internal drives shall be expandable by the user, from a single drive configuration through to 4 high-capacity drives for extensive in-system storage. This in-system storage shall be capable of being set up in an offset mirrored configuration where 1 drive can be mirrored with up to 3 drives.
15. Certain models shall support Raid5 redundancy, supporting block level striping with distributed parity across 4 Hard Drives.
16. Internal system storage shall take advantage of Intelligent Video Archiving and Retention technology that uses the concept of retention rather than recording. A retention based system captures, by default, video from all connected cameras at the highest per-camera frame rates available on the unit (based on model selected), providing always-on high quality recording on all cameras in keeping with the FBI/Scientific Working Group on Image Technology [SWGIT] recommendations. The user shall then be able to set up rules to determine when the retained video is to be removed from the recorder and which video is to be retained.
17. After all of the attached storage has been filled, video of potential interest (e.g., motion video, alarm video, retail or financial transaction video) is reviewed according to the set rules and if tagged, is moved into the Longer-Term Storage area. All other video is removed and the disk space freed up by this 'thinning' process shall be available for new video storage. Beyond long-term storage, a further Extended-Term Storage area shall be available to further thin and retain critical video for an extended period of time.
18. At any time, selected video/audio data shall be available for export by users across the network to their PCs as well as through a USB-connected media storage device (e.g., USB memory stick or USB hard drive) at the NVR. This video shall be completely appropriate for use in evidentiary purposes and shall include a security (authentication) seal for continuity purposes and an auto-run Evidence Reviewer' utility for playback and assessment by third parties such as law enforcement officials.
19. The unit shall simultaneously handle recording, retrieving, and live distribution of video and audio. The unit shall operate in a continuous record mode, even if only event driven recordings, scheduled recordings or motion detection recordings are to be retained for longer periods of time. The unit must be capable of independent operation with network access and control, centralized management in conjunction with a number of other NVR units, or operation under the control of a centralized, enterprise-level suite of multiple-system management software.
20. The unit shall support operation in a local control mode where video can be viewed live and searched using only a mouse and a monitor connected to the HDMI connection. When operating in this mode, the unit does not have to be connected to a network except for the purpose of configuration of the unit. The local control interface shall support the export of

video clips to USB connected media. Local control support is not available on the 4 channel unit.

C. System Security

The unit shall be able to mount on a desktop, wall, or particularly for 32 and 16 channel units, inside a 19" equipment rack with a secure docking station, and have a removable but secured top cover such that the unit cannot be easily powered down or have the disk drive(s) accessed inappropriately.

Each NVR shall be deployed almost exclusively 'behind' an existing network security firewall, benefiting from the default virus protection software and encryption options of that equipment to prevent hacker attacks. In addition, the NVR shall be capable of existing securely on an unprotected network, thereby providing superior security performance relative to most other video systems available.

Each NVR shall use an embedded (in flash memory) Linux operating system, which is inherently more robust in architecture and less susceptible to virus and other "hacker" attacks than other operating systems. Each NVR shall minimize the number of access points for hackers to try and gain access to the unit or by which a virus may attack the unit. Communications with the NVR shall be very restricted, with most external ports being blocked and no way made available to open them. Communication between all entities in the system (client software, management server software, and NVRs) shall be encrypted using SSL encryption.

The NVR unit shall not share any known or unknown vulnerabilities associated with popular PC or computer operating systems. It shall achieve a C2 level of security. All TCP and UDP ports not required for use will be blocked thus ensuring that points of network attack will be minimized.

The NVR unit shall operate without the requirement for a keyboard, monitor or mouse - also known as 'headless' operation – instead being controlled across the network from authorized client PCs. As a result, no tampering shall be possible at the unit itself.

All analog video shall be captured and transmitted to the NVR over coaxial cables, directly connected to the rear of the units. No interception of these video streams shall be possible without physically tapping into the specific cable inside the customer premises.

All IP-camera-based video shall be captured and transmitted to the NVR using the IP protocol. The NVR shall have the capability of connecting with the cameras either through a routed network or directly via the IP camera card.

The NVR unit shall allow for the use of password authentication to prevent unauthorized access to the NVR. Two levels of authentication shall be supported (user and administrator) when the NVR is managed in a peer-to-peer fashion. When the NVR is being managed by server-based management software, the system shall support a large number of users and user groups, as well as a rich set of privileges. In this enterprise configuration, external user authentication using an existing enterprise application shall also be supported, providing the net effect for users of 'single sign-on' or single authentication through their traditional

system access utility.

The NVR shall ensure command and control data packets are encrypted for network transmission using SSL security technology NVR.

The system shall provide the ability to limit operator access to NVR resources. Administrators shall be able to manage user rights to a fine granularity of control, down to the level of access to the individual resource (for example, a single camera, audio channel, or data port).

The local or centralized system administrator shall be able to access all NVR units that are visible on the network, subject to each user's privilege level. Each individual NVR unit shall keep a log of any user access to the unit. The log shall be retrievable remotely by an administrator, but no user will be able to remove entries from the log. The log shall be maintained automatically by removing entries that are six months old. It shall be an option to copy and save the report to a text-formatted file for import into a third party application. It shall be an option to print the report. These capabilities shall be scalable such that they will work seamlessly under the control of a centralized, enterprise-level suite of multiple-system management software.

D. System Management

All NVR units shall be capable of being managed locally or centrally over a TCP/IP LAN or WAN network, using individual system or enterprise-level management utilities. All systems shall be capable of being managed by a set of consistent user interface applications that operate consistently across all members of the NVR product family. The enterprise-level management application shall be capable of managing system programming, monitoring the health of the system in real-time, of upgrading the software on an NVR unit, synchronizing the time on an NVR unit, remotely managing an NVR unit, and more.

Reports on systems use, problems, and alarms shall be capable of being printed. Reports shall also be capable of being copied or saved for importing into third party applications.

E. Automated Configuration

As NVR units are added to the network, the NVR management application shall automatically detect their presence on the network to support rapid configuration and administration.

F. Reliability

1. The NVR shall use an embedded (in flash memory) Linux operating system, which is inherently more robust in architecture and reliability than other operating systems.
2. No NVR operating software shall reside on the NVR hard-drives, eliminating hard-drive failure as a reliability issue and allowing the unit to operate without any hard-drives present (e.g., in a video streaming application, or when utilizing external storage).
3. The NVR unit shall contain hardware and software watchdog circuitry that maximize fault-free operation. The central management application shall report all problems detected by any NVR units on the network. The NVR configuration software shall continuously supervise the health of both the unit and the network, including dial-up extensions. The management utility shall periodically connect to all dial-up connected NVR units in order to ascertain the health of both the unit and the line/modem on which the unit is connected. An option to 'connect on demand' shall also be provided to support low-activity NVR deployments.

4. The NVR shall use SMART disk technology to provide real-time monitoring of all internal hard-disks, including diagnostics and health reporting, to provide further system reliability. The unit shall offer internal disk mirroring in a multi-drive configuration to further protect stored data.
5. The administrator shall control the level of problem reporting (thresholds) in order to ensure the reliability of the NVR and the equipment connected to the NVR unit, but also to manage the amount of communications consumed by this activity. The administrator shall be able to have notification of problems e-mailed to specific users.

G. Video Capture

1. The video compression protocol used by the NVR unit shall be H.264, which uses an inter-frame mechanism to assist in achieving the optimum compression.
2. The NVR shall have an aggregate capture rate of 240 or 480 fps (NTSC) or 200 or 400 fps (PAL) across its 4/8/16 analog inputs, depending on the model selected. The 24 channel unit shall have an aggregate capture rate of 720 fps at 1080P30. On all units, five (5) levels of compressed video quality shall be supported to balance desired video clarity against available hard drive storage.
3. Video capture rates shall be allocated in a flexible manner per camera, with different frame rate settings on each camera. Frame rates can be set anywhere from 1 fps up to 15 or 30 fps per camera input, respecting the limit of the model selected.
4. Per-camera video capture rates shall have the option of being increased (to the maximum available based on system capability) on alarm or event triggering (i.e., detection of motion, activation of a panic alarm button, etc.).
5. The NVR shall be capable of capturing and distributing video at high frame rates while storing at a lower frame rate or vice versa. Display resolutions shall be: NTSC - CIF (352 x 240 pixels), and 4CIF (704 x 480 pixels); PAL -CIF (352 x 288), and 4CIF (704 x 576).

H. Video Loss Detection

The NVR unit shall constantly supervise all enabled video inputs for a synchronization signal and, if enabled, notify the administrator of signal loss. Video sync loss detection shall be filtered to ensure that brief interruptions are masked and problem cameras do not generate excess alarms.

I. Field of View Monitoring

Using video analytic capabilities, the NVR unit shall also provide camera obstruction detection and scene change detection. Both applications will offer user-programmable learning parameters, and alert thresholds, and can be used together or independently.

J. Video Output

The NVR unit shall have looping video inputs plus a single video output (excludes video output on 24, 4 channel unit) which is capable of displaying video from selected camera inputs in a sequenced display application, with a programmable dwell sequence being available for each display. This sequence shall be interruptible in order to display specific video related to an event (i.e., alarm trigger) on the NVR unit, and shall return to the preset sequence once that event has completed.

K. Audio Capture

1. The 32-, 24- and 16-channel NVR shall provide the ability to record 4 channels of audio data synchronized with video data. Audio recording shall be 2-way, half-duplex communication on 2 of the channels. The 8 and 4 channel NVR shall provide the ability to record 2 channels of audio data synchronized with video data. Audio recording shall be 2-way, half-duplex communication on 1 of the channels. The audio compression protocol used shall be ADPCM compression. Four levels of Audio compression (quality) shall be supported.
2. Where audio recording is to accompany video capture, the video and audio shall be synchronized to within one second for both live viewing and playback.
3. Audio shall be recorded separate and distinct from the video such that it can be associated after with any video stream after it has been recorder.

L. Storage

1. The 32 and 16 channel NVR shall support 1 through to 4 internal hard disk drives. The 4 and 8 NVRs channel shall support 1 or 2 internal hard disk drives to provide high-capacity video storage, with the drives having a capacity of at least 3TB each or larger. The 4 channel unit shall support 1 or 2 internal hard disk drives to provide high capacity storage. With drives having a capacity of at least 1TB. No system (NVR) software or operating system elements shall reside on these hard drives, thereby avoiding any reduction in video storage capacity and increasing system robustness.
2. The NVR unit shall contain no removable media for off-line storage. All storage shall be on-line for as long a period as possible based on the configuration that has been selected. Configurable parameters for altering storage duration shall include:
 - Display size (CIF, 2CIF, 4CIF)
 - Frame rate
 - Video quality settings (most detailed, more detailed, medium, more compressed, most compressed)
3. Internal system storage shall take advantage of Intelligent Video Archiving and Retention technology that uses the concept of retention rather than recording. A retention based system captures, by default, video from all connected cameras at the highest per-camera frame rates available on the unit. This provides an always-on high quality recording on all cameras in keeping with the FBI/Scientific Working Group on Image Technology [SWGIT] recommendations. The user shall then be able to set up rules to determine when the retained video is to be removed from the recorder and which video is to be retained.
4. After all of the attached storage has been filled, video of potential interest (e.g., motion video, alarm video, retail or financial transaction video) is reviewed according to the set rules and if tagged, is moved into the, Longer-Term Storage area. All other video is removed and the disk space freed up by this 'thinning' process shall be available for new video storage. Beyond long-term storage, a further Extended-Term Storage area shall be available to further thin and retain critical video for an extended period of time.
5. All video shall be stored at the NVR unit and only be delivered over the network when either the recorded video is searched and retrieved or if live video is requested.

M. Recorded Information

The information recorded on the NVR unit shall consist of the following data:

1. Compressed video
2. Compressed audio
3. Time stamp consisting of date and time with millisecond resolution
4. Associated event information
5. Associated transaction information (for example, retail Point-of-Sale or ATM/Teller financial transactions)
6. Audit information

N. Recorded Format

Compressed video from all cameras shall be stored in such a way that it is independently retrievable. Compressed audio shall be stored in such a way that it is independently retrievable or can be associated with any video input. When a video recording with associated audio is retrieved, the audio shall be retrieved automatically (synchronized) along with the video. The operator shall be able to retrieve a video clip from the NVR unit at any file size up to a maximum of 2.0 GB.

O. Continuous Recording

The NVR unit shall be capable of recording continuously on each video and its audio input. The capacity for recording shall not exceed 40 GB when recording continuously for 7 days on 4 cameras at 15 fps, with a “More Compressed” setting and moderate to low motion. Capacity for recording on IP cameras shall be dependent on the configuration settings of the IP camera.

P. On-Event Recording

1. The NVR unit shall be capable of recording any video input (and associated audio if desired) in response to an external alarm. The recording period shall be of any duration from 30 seconds to seven days. There shall be no hard association of an external alarm to a camera or audio source. Any alarm can cause an action to record on any or all cameras and the audio input.
2. Optionally, any given camera shall be programmable to record at up to the maximum capture rate (fps) available from the system in response to an alarm.
3. Events that trigger long or extended-term retention shall include:
 - Any external closed current loop device connected to the NVR unit (door sensor, motion sensor, etc.)
 - Motion in the video image (in the image overall, or in individual and configurable ‘masked’ areas of the image, with configurable sensitivity settings)
4. Extended retention on video motion detection shall be tunable using full screen sensitivity setting to simplify configuration or using a user definable grid for area of interest. In order to reduce the frequency of motion alarms, the detection of next occurrence of motion can be delayed until there is a period of inactivity in the image. Detection of video motion shall be capable of being enabled during specific periods of the day according to a pre-determined schedule.

Q. Scheduled Recording

The NVR unit shall be capable of executing any number of internal recording schedules defined by the administrator. Schedules shall be remotely configurable and control the following actions:

1. Extended retention (any combination of cameras for any duration from 30 seconds to 7 days)
2. Monitoring of physical alarms (during specified periods)
3. Monitoring of motion alarms (during specified periods)
4. Increase of the bandwidth throttle
5. Assertion of a switch (for a specified period)
6. Moving of a PTZ unit to a predefined position
7. Displaying of a specific camera on the spot monitor

R. Time Synchronization

The NVR unit shall allow for clock synchronization to occur manually or from a central location through a network time protocol (NTP) server or enterprise management server. The NVR unit shall also be capable of automatically adjusting the clock to Daylight Saving Time, and adjusting for deployment in varying time zones.

S. Live Video/Audio Viewing

The NVR viewing application shall be capable of displaying up to 36 video windows simultaneously in a 6 x 6 grid with video from cameras on the same NVR as well as video from different NVRs. Live video windows shall be able to co-exist on one monitor or across several, with playback windows on the same screen from within the same application. Each video/audio window shall have independent control and all windows shall be capable of being linked together and controlled simultaneously. Each video/audio window shall be capable of performing an instant replay of selected duration by simply using a slider control to move back in time. If audio is associated with the selected window there shall be a set of controls to adjust the volume or mute the audio.

T. Video Zoom/Full Screen Display

The currently selected video window shall support digital zooming of 50 percent to 200 percent using pre-defined buttons. As well, wire frame selection of area to zoom shall also be supported with the ability to pan to areas of interest that are outside of the displayed window frame. The displayed video shall have an option to adjust to the size of the window frame. Multiple windows shall be capable of having the zoom and fit-to-screen operations applied simultaneously. Any single video window shall be capable of being displayed in full screen mode with no window frame (audio will continue to be heard in this mode).

U. PTZ control

1. The NVR unit shall allow for connection to PTZ cameras through the RS-232 or RS-485 ports on the unit, and multiple PTZ cameras may be 'daisy-chained' on a single port as defined by the PTZ protocol the user deploys (see #2 below). Control of these cameras shall be possible on the operator side through a physical connection to a PTZ controller (keypad/joystick) or through on-screen software controls. On-screen software controls shall allow for selection of PTZ camera to control, direction of camera movement, zoom, focus and configuration of camera preset locations.
2. At a minimum, the following PTZ camera protocols shall be supported on the NVR:
 - Kalatel® KTD-312
 - Panasonic® WV-CS850

- Pelco® D
- Pelco® P
- Phillips® TC700/TC8560
- RVision®
- Sony® UniDome UNI-TR1
- Ultrak® KD-6

V. Video Image Settings

The video window shall support image controls for brightness, contrast, saturation, and hue levels to customize the appearance of video in the active display window. Recorded video is in no way altered by these controls, however, printed or saved still images can be image enhanced.

W. Dataports

The NVR unit shall be able to capture and store banking ATM/Teller or retail Point-of-Sale (POS) transaction information using the RS-232 data port or 10/100 base T RJ-45 connection available on the unit. The text information captured from a transaction system shall not overlay or obstruct the video in any way, but shall be synchronized with that video, and shall serve as a trigger to capture recorded video of preset duration (including pre-transaction video).

X. Switch Control

The NVR viewer shall be able to manually control devices connected to the switch output of the NVR unit by activating one either normally open (NO) or normally closed (NC) contact. The switch shall automatically reset after a configurable period of time. The switch shall also be set in response to an external event occurring or as a scheduled operation.

Y. Alarm Notification

The NVR unit shall distribute notification of alarms to clients who have requested notification. All video associated with the alarm shall be automatically displayed on receipt of an alarm. Audible and visual alarm cues shall also be optionally configurable. An operator shall be able to have notification of alarms e-mailed to specific users.

Z. Time Zones

The NVR unit shall be capable of operating in a different time zone than a viewing application. The operator shall be able to work in either the time zone of their PC or the time zone of the NVR when searching for video. Operator software shall display either the local (user) time zone, or the time zone of the NVR when displaying video timestamps.

AA. Search of Alarms

1. Video recorded on alarms shall be searchable by selecting the alarm of interest and entering a specific point in time and period of interest. Each type of alarm shall have a unique icon to represent it in the list. An operator shall be able to narrow down the search without having to re-enter all the parameters. All alarm-associated recordings (i.e. all cameras) shall be retrieved and displayed by selecting a specific entry from the alarm search results. The duration of retrieved video surrounding the alarm point shall be configurable by each user.
2. Video motion alarms shall be handled in the same way as other physical alarms. A mask shall be able to be applied to a search for video motion such that the results list displays only when motion was detected in the area(s) of interest.

3. Transaction events captured from an ATM or bank Teller machine interface shall be handled in the same way as other physical alarms, in that they shall be searchable by date and time as well as other custom user data. The search fields for ATM/Teller transaction alarms shall include:
 - Transaction type
 - Transaction number
 - Transaction amount
 - Card number
 - Time/date stamp
 - Other custom field
5. Transaction events captured from a Point-of-Sale (POS) retail interface shall be handled in the same way as other physical alarms, in that they shall be searchable by date and time as well as other custom user data. The search fields for POS transaction alarms shall include:
 - Transaction type
 - Transaction number
 - Transaction amount
 - Card number
 - Time/date stamp
 - Other custom field
6. A range will be used when searching on either transaction amounts (e.g., from \$1000.00 to \$5000.00, or from \$0.00 to \$100.00, with a maximum of \$1,000,000.00).

BB. Search and Retrieval of Recordings

1. Searching and retrieving video and audio from the NVR unit shall be done as a single operation (i.e. if the audio is associated with the video, it will be retrieved as well).
2. The search function shall allow multiple cameras, multiple NVRs, or multiple NVR locations to be specified and searched simultaneously.
3. Recorded video shall be searchable by:
 - Selecting the camera of interest and entering a range of times. The user shall be able to further refine this range by a simple “click-and-drag” operation, and not have to re-enter any search parameters. The user shall be presented with a histogram indicating the amount of motion during the time range, as well as a set of thumbnails to aid in pinpointing a time of interest.
 - Selecting an alarm and using the specific point in time of the alarm to locate the associated video
 - Using the ‘activity scan’ feature to search based on motion detection
 - Specifying ATM or POS transaction data as mentioned above
7. The search function shall allow any duration of video to be retrieved (to a maximum file size of 2.0 GB).

CC. Playback Viewing

The retrieved video shall be displayed automatically in a window. The playback windows shall be capable of being displayed alongside the live video windows. If audio is associated with the video that is retrieved, it shall be automatically played when the video is played. A date/time stamp shall appear with the video being displayed and shall be updated for each frame that is displayed.

DD. Playback Controls

1. When a playback window is selected, the following controls shall be made available to control the playback of the video:
 - Play – forward and reverse
 - Pause
 - Single frame – forward and reverse.
 - Move to beginning to ending of video segment
8. In addition, the play speed shall be capable of being changed to 1x, 2x, and 4x normal speed. The recorded video shall also be capable of being quickly navigated using a shuttle search (slide bar). Video frames shall be displayed while the slide bar is being moved to assist in finding the frame of interest.

EE. Time Ruler

For navigation through a video clip, the operator shall be able to use a slide bar. The video image shall update while the slide bar is being moved. To change the time resolution for more accurate navigation, the time ruler shall be capable of being zoomed in or out.

FF. Video Images - Copy, Save and Print

An image from a live or playback video window shall be capable of being manipulated as follows:

1. The image shall be capable of being copied to the PC 'clipboard' and then pasted into any third party application that will accept data from that clipboard. These applications include image enhancement, email, or word processing. Image copying options shall include specifying standard JPEG or .BMP file formats for the image. The copied information shall include both video and associated detail data (location, camera, time, date, and event information).
2. The resulting images shall then be able to be saved to the local PC or other network storage location, retaining their JPEG or .BMP file formats and their associated detail data.
3. The images shall also be capable of being printed to any network-connected printer. The printed image shall have the associated detail data (location, camera, time, and date) printed on the same page.

GG. Video Clips – Security Sealed

A video clip from a live or playback video window shall be capable of being controlled as follows:

1. The video clip shall be capable of being saved to the local PC or other network storage location in an industry-standard .AVI read-only file format. The captured information shall include the video clip itself, any audio data if recorded, and associated location, camera, time, date and event details, as well as any captured POS or ATM transaction data.
2. All video clips shall have a tamper-proof security seal applied automatically as part of this process, ensuring the authenticity of that video and its admissibility as evidence in a legal

investigation or prosecution process. This security seal process shall be based on the SHA (Secure Hash Algorithm) of Digital Signature Standard [U.S. FIPS PUB 180-1, 1995].

3. Video clips shall be able to be exported from the NVR to a USB-connected CD Burner or memory stick. Control of this operation shall be made available to authorized clients locally or remotely over the network. This export process shall include the copying of a free, auto-run Evidence Reviewer utility with which third parties may play back the video clip. Users of the Evidence Reviewer utility shall have the ability to run the utility directly from the media, without requiring them to install it on their workstations.
4. The industry-standard .AVI video files shall be capable of being displayed by any commercial application that will render such media files. To display all associated detail data, and to verify authenticity of the video, the Evidence Reviewer utility shall be necessary.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Examine site conditions prior to installation. Notify Architect and Owner in writing if unsuitable conditions are encountered. Do not start installation until site conditions are acceptable.
- C. If preparation is the responsibility of another installer, notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.

3.2 INSTALLATION

- A. All components of the recorder shall be thoroughly tested before shipping to the project location.
- B. Recorder shall be installed, programmed and tested in accordance with manufacturer's installation instructions.
 1. Coordinate interfaces with Owner's representative where appropriate.
 2. Provide backboxes, racks, connectors, supports, conduit, cable, and wire for a complete and reliable installation. Obtain Owner's approval for exact location of all boxes, conduit, and wiring runs prior to installation.
 3. Install conduit, cable, and wire parallel and square with building lines, including raised floors areas. Do not exceed forty percent (40 percent) fill in conduits. Gather wires and tie to create an orderly installation.
 4. Coordinate with other trades to provide proper sequencing of installation.

3.3 FIELD COMMISSIONING

- B. Test recorder as recommended by manufacturer, including the following:

1. Conduct complete inspection and testing of equipment, including verification of operation with connected equipment.
2. Test devices and demonstrate operational features for Owner's representative and authorities having jurisdiction, as applicable.
3. Correct deficiencies until satisfactory results are obtained.
4. Submit written copies of test results.

3.4 TRAINING AND CERTIFICATION

- A. The recorder manufacturer shall offer free online training for authorized dealer technicians through user controlled portal access.
- F. Training material shall cover all aspects of installation, configuration and maintenance.
- G. The dealer shall receive a certificate upon the successful completion of the certification exam. Certifications shall be valid for a period of 2 years.
- H. The recorder manufacturer shall offer free online training tutorials for system administrators accessible 24/7 via open (non-restricted) website for an unlimited number of system users. The training tutorial shall cover the system, User management, Health alert management and Mass Management (upgrades) of all registered devices on the recorder.
- I. The recorder manufacturer shall offer free online training for Guards and Investigators accessible 24/7 via open (non-restricted) website for an unlimited number of system users. The training tutorial shall cover system access, live and archive media requests, alarm inbox management, as well as extracting media from the system

END OF SECTION

Axis IP Cameras

GENERAL

The CCTV cameras installed at City of XXXX sites are to be manufactured by Axis Communications.. The system integrator providing the equipment will ensure that all units are in compliance with the general requirements listed in section 2.4 of this document.

1.01 SYSTEM DESCRIPTION

General Requirements

1. The specified unit shall be of manufacturer's official product line, designed for commercial and/or industrial 24/7/365 use.
2. The specified unit shall be based upon standard components and proven technology using open and published protocols.

A. Sustainability

1. The specified unit shall be manufactured in accordance with ISO 14001.
2. The specified unit shall be compliant with the EU directives 2011/65/EU (RoHS) and 2012/19/EU (WEEE).
3. The specified unit shall be compliant with the EU regulation 1907/2006 (REACH).

1.02 CERTIFICATIONS AND STANDARDS

B. General abbreviations and acronyms

1. AGC: Automatic gain control
2. API: Application Programming Interface
3. Aspect ratio: A ratio of width to height in images
4. Bit Rate: The number of bits/time unit sent over a network
5. Bonjour: Enables automatic discovery of computers, devices, and services on IP networks.
6. DHCP: Dynamic Host Configuration Protocol
7. DNS: Domain Name System
8. EIS: Electronic Image Stabilization
9. FPS: Frames per Second
10. FTP: File Transfer Protocol
11. H.264 (Video Compression Format)
12. IEEE 802.1x: Authentication framework for network devices
13. IP: Internet Protocol
14. IR light: Infrared light
15. JPEG: Joint Photographic Experts Group (image format)
16. LAN: Local Area Network
17. LED: Light Emitting Diode
18. Lux: A standard unit of illumination measurement
19. MBR: Maximum Bit Rate
20. MPEG: Moving Picture Experts Group
21. Multicast: Communication between a single sender and multiple receivers on a network
22. NTP: Network Time Protocol

23. NTSC: National Television System Committee – a color encoding system based on 60Hz
24. ONVIF: Global standard for the interface of IP-based physical security products
25. PAL: Phase Alternating Line – a color encoding system based on 50Hz
26. PoE: Power over Ethernet (IEEE 802.3af/at) standard for providing power over network cable
27. Progressive scan: An image scanning technology which scans the entire picture
28. PTZ: Pan/Tilt/Zoom
29. QoS: Quality of Service
30. SIP: Session Initiation Protocol
31. SMTP: Simple Mail Transfer Protocol
32. SMPTE: Society of Motion Picture and Television Engineers
33. SNMP: Simple Network Management Protocol
34. SSL: Secure Sockets Layer
35. TCP: Transmission Control Protocol
36. TLS: Transport Layer Security
37. Unicast: Communication between a single sender and single receiver on a network
38. UPnP: Universal Plug and Play
39. UPS: Uninterruptible Power Supply
40. VBR: Variable Bit Rate
41. VMS: Video Management System
42. WDR: Wide dynamic range

A. The specified unit shall carry the following EMC approvals:

1. EN55022 Class A, EN55024, EN61000-6-1, EN61000-6-2
2. FCC Part 15 - Subpart B Class A
3. VCCI: 2014, Class A, ITE
4. C-tick AS/NZS CISPR22 Class A
5. ICES-003 Class A
6. KCC KN22 Class A, KN24

B. The specified unit shall meet the following product safety standards:

1. IEC/EN/UL 60950 -1
2. IEC/EN/UL 60950-22

C. The specified unit shall meet relevant parts of the following video standards:

1. SMPTE 296M (HDTV 720p)

D. The specified unit shall meet the following standards

1. MPEG-4:
 - a. ISO/IEC 14496-10 Advanced Video Coding (H.264)
2. Networking:
 - a. IEEE 802.3af/802.3at (Power over Ethernet)
 - b. IEEE 802.1X (Authentication)
 - c. IPv4 (RFC 791)
 - d. IPv6 (RFC 2460)
 - e. QoS – DiffServ (RFC 2475)
3. Network video
 - a. Relevant ONVIF profile as defined by the ONVIF Organization.

4. Mechanical Environment:
 - a. IEC/EN 60529 IP66 & IP67
 - b. NEMA 250 Type 4X
 - c. IEC/EN 62262 IK08
 - d. IEC 60068-2-6
 - e. IEC 60068-2-27

1.03 QUALITY ASSURANCE

1. The Contractor or security sub-contractor shall be a licensed security Contractor with a minimum of five (5) years' experience installing and servicing systems of similar scope and complexity and evidence that is completed at least three (3) projects of similar design and is currently engaged in the installation and maintenance of systems herein described.
2. All installation, configuration, setup, program and related work shall be performed by electronic technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.
3. The contractor or designated sub-contractor shall submit credentials of completed manufacturer certification, verified by a third party organization, as proof of the knowledge.
4. The Contractor shall provide four (4) current references from clients with systems of similar scope and complexity that became operational in the past three (3) years.
5. The specified unit shall be manufactured in accordance with ISO9001.

1.04 WARRANTY

- a. All security system components and labor furnished by the contractor including wiring, software, hardware and custom parts shall be fully warranted for parts, materials, labor and travel expenses for a minimum of three (3) years from date of the final acceptance of the Video Surveillance System.
- b. The manufacturer shall provide warranty and optional extended warranty for the camera for a total period of maximum five years. If enacted as part of the contract, the contractor will repair or replace parts and/or labor per the warranty for the length of this warranty at no cost to the client.

Part 2: PRODUCTS

2.01 General

- a. Cameras shall be IP-based and comply with established network and video standards.
- b. Cameras shall be powered by the switch utilizing the network cable. Power injectors (midspans) shall be provided by the contractor when required for proper operation.
- c. Cameras shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
- d. Network door stations shall comply with relevant ONVIF profile as defined by the ONVIF Organization.

2.02 Video Surveillance schedule

- a. Camera types listed below describing various resolutions, form-factor and features shall be supplied by a single camera manufacturer.
- b. The camera manufacturer and model numbers will be as follows:
 - a. Indoor low end fixed shall be Axis M3065-v
 - b. Indoor Fixed Dome shall be Axis P3245-LV MKII
 - c. Outdoor Fixed Dome shall be Axis P3245-LVE MKII
 - d. Outdoor Fixed Dome 6.0MP Camera shall be Axis M3057-PLVE
 - e. Indoor Fixed Minidome shall be Axis M30-V
 - f. Indoor Fixed Dome 2MP/1080P shall be Axis P3245-LV
 - g. Indoor/Outdoor PTZ shall be Axis M5654-E
 - h. 720P PTZ shall be Axis P5634-E MKII
 - i. Outdoor 1080P PTZ shall be Axis Q6055-E
 - j. 360 degree Multi-sensor (4) with optional PTZ shall be Axis Q6000-E
 - k. Outdoor Panoramic 15MP Dome camera shall be Axis P3719-PLE

A. Fixed dome 3Mpxl network camera

1. The fixed dome network camera shall meet or exceed the following design specifications:
 - a. The camera shall operate on an open source; Linux-based platform and including a built-in web server.
 - b. The camera shall be equipped with an IR-sensitive progressive scan megapixel sensor.
 - c. The camera shall provide a removable IR-cut filter, providing day/night functionality.
 - d. The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion, supporting memory up to 64 GB.
 - e. The camera shall be manufactured with an IP66- and NEMA 4X-rated, IK10 impact-resistant aluminum casing.
 - f. The camera shall provide a manual 3-axis (pan/tilt/rotation) positioning to allow adjustment for optimum camera rotation and placement.
2. The fixed dome network camera shall meet or exceed the following performance specifications:
 - a. Illumination
 1. The camera shall meet or exceed the following illumination specifications:
 - a. 0.3 lux in color
 - b. 0.06 lux in B/W
 - b. Resolution
 1. The camera shall be designed to provide individually configured video streams in 3 MP (2048x1536) at 16/20 frames per second in power line frequency 50/60 Hz, using H.264 or Motion JPEG.
 2. The camera shall support video resolutions including:
 - a. 2048x1536
 - b. 1920x1080 (HDTV 1080p)
 - c. 1600x1200
 - d. 1280x1024

- e. 1280x960
- f. 1280x720 (HDTV 720p)

3. The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).

c. Encoding

1. The camera shall support the following video encoding algorithms:
 - a. Motion JPEG encoding in a selectable range from 1 up to 16/20 frames per second at capture mode 3 MP (2048x1536), up to 25/30 frames per second at capture mode 2 MP (1600x1200 and up to 25/30 frames per second at capture mode HDTV 1080p (1920x1080).
 - b. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in a selectable range from 1 up to 16/20 frames per second at capture mode 3 MP (2048x1536), up to 25/30 frames per second at capture mode 2 MP (1600x1200 and up to 25/30 frames per second at capture mode HDTV 1080p (1920x1080).
 - c. Baseline Profile H.264 encoding with motion estimation in a selectable range from 1 up to 16/20 frames per second at capture mode 3 MP (2048x1536), up to 25/30 frames per second at capture mode 2 MP (1600x1200 and up to 25/30 frames per second at capture mode HDTV 1080p (1920x1080)
2. The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
3. The camera shall in H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate speaks the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
4. The camera shall provide configurable compression levels.
5. Support motion estimation in H.264/MPEG-4 Part 10/AVC.

d. Transmission

1. The camera shall allow for video to be transported over:
 - a. HTTP (Unicast)
 - b. HTTPS (Unicast)
 - c. RTP (Unicast & Multicast)
 - d. RTP over RTSP (Unicast)
 - e. RTP over RTSP over HTTP (Unicast)
2. The camera shall support Quality of Service (QoS) to be able to prioritize traffic.

e. Image

1. The camera shall incorporate Automatic and Manual White Balance.
2. The camera shall incorporate an electronic shutter operating in the range of 1/30500 s to 2 s.
3. The camera shall incorporate capture mode with the following settings:
 - a. 2 MP (1600x1200) and HDTV 1080p (1920x1080) - 25/30 fps
 - b. 3 MP - 16/20 fps
4. The camera shall incorporate Wide Dynamic Range – Dynamic contrast.

5. The camera shall provide backlight compensation functionality.
 6. The camera shall support manually defined values for:
 - a. Color level
 - b. Brightness
 - c. Sharpness
 - d. Contrast
 7. The camera shall incorporate a function for optimization of low light behavior.
 8. The camera shall allow for rotation of the image in steps of 90°.
- f. User Interface
1. Web server
 - a. The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - b. Optional components downloaded from the camera for specific tasks, e.g. Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
 2. Language Specification
 - a. The camera shall provide a function for altering the language of the user interface and shall include support for at least 10 different languages.
 3. IP addresses
 - a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
 - c. The camera shall provide support for both IPv4 and IPv6.
- g. PTZ functionality
1. The camera shall:
 - a. Provide Digital PTZ functionality.
 - b. Provide:
 1. Pan: $\pm 175^\circ$
 2. Tilt 70°
 3. Rotation $\pm 180^\circ$
- h. Event functionality
1. The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a. Video Motion Detection
 - b. Live Stream Accessed
 - c. Camera tampering
 - d. Manual Trigger/Virtual Inputs
 - e. PTZ functionality
 - f. External input

- g. Embedded third party applications
- h. Edge storage disruption detection
- 2. Response to triggers shall include:
 - a. Send notification, using HTTP, HTTPS, TCP, SNMP trap or email
 - b. Send images, using FTP, HTTP, HTTPS, network share or email
 - c. Send video clip, using FTP, HTTP, HTTPS, network share or email
 - d. Recording to local storage and/or network attached storage
 - e. Activating external output
 - f. PTZ control functionality
- 3. The camera shall provide memory for pre & post alarm recordings.
- i. Edge storage
 - 1. The camera shall support continuous and event controlled recording to:
 - a. Local memory added to the cameras SD-card slot
 - b. Network attached storage, located on the local network
 - 2. The camera shall be able to detect and notify Edge storage disruptions.
- j. Protocol
 - 1. The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, SSH, NTP, CIFS/SMB, Bonjour.
 - 2. The SMTP implementation shall include support for SMTP authentication.
- k. Text overlay
 - 1. The camera shall:
 - a. Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 - b. Provide the ability to apply privacy masks to the image.
 - c. Allow for the overlay of a graphical image, such as a logotype, into the image.
- l. Security
 - 1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 - 2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
 - 3. The camera shall support IEEE 802.1X authentication.
 - 4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
 - 5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.
- m. API support

1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
 2. The camera shall support relevant ONVIF profiles as defined by the ONVIF Organization.
- n. Embedded applications
1. The camera shall provide a platform allowing the upload of third party applications into the camera.
- o. Installation and maintenance
1. The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
 2. The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
 3. The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
 4. The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
 5. The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
 6. The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
- p. Access log
1. The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
 2. Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
- q. Camera diagnostics
1. The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
 2. The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
 3. The camera shall send a notification when the unit has re-booted and all services are initialized.
- r. Hardware interfaces
1. Network interface
 - a. The camera shall be equipped with one 100BASE-TX Fast Ethernet-port, using a standard male RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
 2. Inputs/Outputs

- a. The camera shall be equipped with one digital (alarm) input and one digital output, accessible via a removable terminal block. This input shall be configurable to respond to normally open (NO) or normally closed (NC) dry contacts.
 - s. Enclosure
 - 1. The camera shall:
 - a. Be manufactured with an IP66- and NEMA 4X-rated, IK10 impact-resistant aluminum casing.
 - b. Be fitted with a clear transparent cover
 - c. Be equipped with a preinstalled 2 m (6.6 ft) network cable.
 - t. Power
 - 1. Power over Ethernet IEEE 802.3af/802.3at Type 1 Class 2
 - u. Environmental
 - 1. Operate in a temperature range of -30 °C to +50 °C (-22 °F to 122 °F).
 - 2. Operate in a humidity range of 10–100% RH (condensing).
- B. Fixed indoor dome 1080p network camera
- 1. The fixed dome network camera shall meet or exceed the following design specifications:
 - a. The camera shall operate on an open source; Linux-based platform and including a built-in web server.
 - b. The camera shall be equipped with an IR-sensitive progressive scan megapixel sensor.
 - c. The camera shall provide a removable IR-cut filter, providing day/night functionality.
 - d. The camera shall be equipped with a varifocal lens with P-iris.
 - e. The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
 - f. The camera shall be manufactured with an IP52-rated, IK08 impact-resistant, polycarbonate casing.
 - g. The camera shall provide a manual 3-axis (pan/tilt/rotation) positioning to allow adjustment for optimum camera rotation and placement.
 - h. The camera shall provide options for clear and smoked lower dome.
 - 2. The fixed dome network camera shall meet or exceed the following performance specifications:
 - a. Illumination
 - 1. The camera shall meet or exceed the following illumination specifications:
 - a. HDTV 1080p 25/30 fps with WDR - forensic capture
 - 1. 0.16 lux at 50 IRE, F1.4 (color)
 - 2. 0.03 lux at 50 IRE, F1.4, 0 lux with IR illumination on (B/W)
 - b. HDTV 1080p 50/60 fps without WDR - forensic capture
 - 1. 0.32 lux at 50 IRE, F1.4 (color)
 - 2. 0.06 lux at 50 IRE, F1.4, 0 lux with IR illumination on (B/W)
 - 2. Camera shall have Lightfinder Technology
 - b. Resolution

1. The camera shall be designed to provide at least two video streams in HDTV 1080p (1920x1080) at up to 60 frames per second (60Hz mode) or 50 frames per second (50Hz mode) using H.264 or Motion JPEG (WDR inactive).
2. The camera shall be designed to provide at least two video streams in HDTV 1080p (1920x1080) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264 or Motion JPEG (WDR active).
3. The camera shall be designed to provide 2 individually cropped out view areas.
4. The camera shall support video resolutions including:
 - a. 1920x1080 (HDTV 1080p)
 - b. 1280x960
 - c. 1280x720 (HDTV 720p)
 - d. 1024x768
 - e. 1024x640
5. The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).

c. Encoding

1. The camera shall support the following video encoding algorithms:
 - a. Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second.
 - b. Motion JPEG encoding in a selectable range from 1 up to 50/60 frames per second.
 - c. Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
 - d. Baseline Profile H.264 encoding with motion estimation in up to 50/60 frames per second.
 - e. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second.
 - f. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 50/60 frames per second.
 - g. Support High Profile H.264 encoding with motion estimation up to 25/30 frames per second.
 - h. Support High Profile H.264 encoding with motion estimation up to 50/60 frames per second.
 - i. Support H.264 with automatic scene adaptive bitrate control.
2. The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
3. The camera shall in H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate spikes the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
4. The camera shall provide configurable compression levels.
5. Support standard baseline profile H.264 with motion estimation.
6. Support motion estimation in H.264/MPEG-4 Part 10/AVC.

7. The camera shall have Zipstream technology, an H.264 implementation that supports scene adaptive bitrate control with the following capabilities to lower bandwidth and storage.
 - a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
 - b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
 - c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements
- d. Transmission
 1. The camera shall allow for video to be transported over:
 - a. HTTP (Unicast)
 - b. HTTPS (Unicast)
 - c. RTP (Unicast & Multicast)
 - d. RTP over RTSP (Unicast)
 - e. RTP over RTSP over HTTP (Unicast)
 2. The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- e. Image
 1. The camera shall incorporate Automatic and Manual White Balance.
 2. The camera shall incorporate an electronic shutter operating in the range of 1/66500 s to 1 s.
 3. The camera shall incorporate capture mode with the following settings:
 - a. 25/30 fps (WDR-Forensic Capture) (50/60 Hz)
 - b. 50/60 fps (no WDR-Forensic Capture) (50/60 Hz)
 4. The camera shall incorporate Wide Dynamic Range - Forensic Capture functionality providing up to 120dB dynamic range.
 5. The camera shall support manually defined values for:
 - a. Color level
 - b. Brightness
 - c. Sharpness
 - d. Contrast
 6. The camera shall incorporate a function for optimization of low light behavior.
 7. The camera shall allow for rotation of the image in steps of 90°.
- f. IR Illumination
 1. The camera shall be equipped with built-in IR LEDs with adjustable illumination intensity.
 - a. The IR LEDs shall have a range of up to 30 m (100 ft).
 - b. The IR LEDs shall emit light with a wavelength of 850 nm.
- g. User Interface
 1. Web server
 - a. The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.

- b. Optional components downloaded from the camera for specific tasks, e.g. Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
- 2. Language Specification
 - a. The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
- 3. IP addresses
 - a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
 - c. The camera shall provide support for both IPv4 and IPv6.
- h. PTZ functionality
 - 1. The camera shall:
 - a. Provide Digital PTZ functionality.
- i. Event functionality
 - 1. The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a. Video Motion Detection
 - b. Live Stream Accessed
 - c. Day/Night Mode
 - d. Camera tampering
 - e. Manual Trigger/Virtual Inputs
 - f. PTZ functionality
 - g. Embedded third party applications
 - h. Edge storage disruption detection
 - 2. Response to triggers shall include:
 - a. Send notification, using HTTP, HTTPS, TCP, SNMP trap or email
 - b. Send images, using FTP, HTTP, HTTPS, network share or email
 - c. Send video clip, using FTP, HTTP, HTTPS, network share or email
 - d. Send SNMP trap message
 - e. Activate/Deactivate IR Illumination
 - f. Recording to local storage and/or network attached storage
 - g. PTZ control functionality
 - h. WDR mode
 - 3. The camera shall provide memory for pre & post alarm recordings.
- j. Edge storage
 - 1. The camera shall support continuous and event controlled recording to:
 - a. Local memory added to the cameras microSD-card slot
 - b. Network attached storage, located on the local network

2. The camera shall be able to detect and notify Edge storage disruptions.
- k. Protocol
1. The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, SSH, NTP, CIFS/SMB, Bonjour.
 2. The SMTP implementation shall include support for SMTP authentication.
- l. Text overlay
1. The camera shall:
 - a. Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 - b. Provide the ability to apply privacy masks to the image.
 - c. Allow for the overlay of a graphical image, such as a logotype, into the image.
- m. Security
1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
 3. The camera shall support IEEE 802.1X authentication.
 4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
 5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.
- n. API support
1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
 2. The camera shall support relevant ONVIF profiles as defined by the ONVIF Organization.
- o. Embedded applications
1. The camera shall provide a platform allowing the upload of third party applications into the camera.
- p. Installation and maintenance
1. The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
 2. The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
 3. The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.

4. The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
 5. The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
 6. The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
 7. The camera shall provide Remote zoom and Remote focus functionality.
- q. Access log
1. The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
 2. Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
- r. Camera diagnostics
1. The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
 2. The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
 3. The camera shall send a notification when the unit has re-booted and all services are initialized.
- s. Hardware interfaces
1. Network interface
 - a. The camera shall be equipped with one 10BASE-T/100BASE-TX PoE Fast Ethernet-port, using a standard connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
- t. Enclosure
2. The camera shall:
 - a. Be manufactured with an IP52-rated, IK08 impact-resistant, polycarbonate casing.
 - b. Be fitted with a dehumidifying membrane.
 - c. Providing encapsulated electronics and captive screws.
- u. Power
1. Power over Ethernet IEEE 802.3af/802.3at Type 1 Class 3
 - a. Max: 10.2 W
 - b. Typical 6.1 W
- v. Environmental
1. Operate in a temperature range of 0 °C to +50 °C (+32 °F to 122 °F).
 2. Operate in a humidity range of 10–85% RH (non-condensing).

C. Fixed outdoor dome 1080p network camera

1. The fixed dome network camera shall meet or exceed the following design specifications:
 - a. The camera shall operate on an open source; Linux-based platform, and including a built-in web server.
 - b. The camera shall be equipped with an IR-sensitive progressive scan megapixel sensor.
 - c. The camera shall provide a removable IR-cut filter, providing day/night functionality.
 - d. The camera shall be equipped with a varifocal lens with P-iris.
 - e. The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
 - f. The camera shall be manufactured with an IP66- and NEMA 4X-rated, IK10 impact-resistant casing.
 - g. The camera shall provide a manual 3-axis (pan/tilt/rotation) positioning to allow adjustment for optimum camera rotation and placement.
 - h. The camera shall provide options for clear and smoked lower dome.
2. The fixed dome network camera shall meet or exceed the following performance specifications:
 - a. Illumination
 1. The camera shall meet or exceed the following illumination specifications:
 - a. HDTV 1080p 25/30 fps with WDR - forensic capture
 1. 0.16 lux at 50 IRE, F1.4 (color)
 2. 0.03 lux at 50 IRE, F1.4, 0 lux with IR illumination on (B/W)
 - b. HDTV 1080p 50/60 fps without WDR - forensic capture
 1. 0.32 lux at 50 IRE, F1.4 (color)
 2. 0.06 lux at 50 IRE, F1.4, 0 lux with IR illumination on (B/W)
 2. Camera shall have Lightfinder Technology
 - b. Resolution
 1. The camera shall be designed to provide at least two video streams in HDTV 720p (1280x720) at up to 60 frames per second (60Hz mode) or 50 frames per second (50Hz mode) using H.264 or Motion JPEG (WDR inactive).
 2. The camera shall be designed to provide at least two video streams in HDTV 720p (1280x720) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264 or Motion JPEG (WDR active).
 3. The camera shall be designed to provide 2 individually cropped out view areas.
 4. The camera shall support video resolutions including:
 - a. 1920x1080 (HDTV 1080p)
 - b. 1280x960
 - c. 1280x720 (HDTV 720p)
 - d. 1024x768
 - e. 1024x640
 5. The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).
 - c. Encoding

1. The camera shall support the following video encoding algorithms:
 - a. Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second.
 - b. Motion JPEG encoding in a selectable range from 1 up to 50/60 frames per second.
 - c. Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
 - d. Baseline Profile H.264 encoding with motion estimation in up to 50/60 frames per second.
 - e. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second.
 - f. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 50/60 frames per second.
 - g. Support High Profile H.264 encoding with motion estimation up to 25/30 frames per second.
 - h. Support High Profile H.264 encoding with motion estimation up to 50/60 frames per second.
 - i. Support H.264 with automatic scene adaptive bitrate control.
2. The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
3. The camera shall in H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate spikes the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
4. The camera shall provide configurable compression levels.
5. Support standard baseline profile H.264 with motion estimation.
6. Support motion estimation in H.264/MPEG-4 Part 10/AVC.
7. The camera shall have Zipstream technology, an H.264 implementation that supports scene adaptive bitrate control with the following capabilities to lower bandwidth and storage.
 - a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
 - b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
 - c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements
- d. Transmission
 1. The camera shall allow for video to be transported over:
 - a. HTTP (Unicast)
 - b. HTTPS (Unicast)
 - c. RTP (Unicast & Multicast)
 - d. RTP over RTSP (Unicast)
 - e. RTP over RTSP over HTTP (Unicast)
 2. The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- e. Image
 1. The camera shall incorporate Automatic and Manual White Balance.

2. The camera shall incorporate an electronic shutter operating in the range of 1/66500 s to 1 s.
 3. The camera shall incorporate capture mode with the following settings:
 - a. 25/30 fps (WDR-Forensic Capture) (50/60 Hz)
 - b. 50/60 fps (no WDR-Forensic Capture) (50/60 Hz)
 4. The camera shall incorporate Wide Dynamic Range - Forensic Capture functionality providing up to 120dB dynamic range.
 5. The camera shall support manually defined values for:
 - a. Color level
 - b. Brightness
 - c. Sharpness
 - d. Contrast
 6. The camera shall incorporate a function for optimization of low light behavior.
 7. The camera shall allow for rotation of the image in steps of 90°.
- f. IR Illumination
1. The camera shall be equipped with built-in IR LEDs with adjustable illumination intensity.
 - a. The IR LEDs shall have a range of up to 30 m (100 ft).
 - b. The IR LEDs shall emit light with a wavelength of 850 nm.
- g. User Interface
1. Web server
 - a. The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - b. Optional components downloaded from the camera for specific tasks, e.g. Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
 2. Language Specification
 - a. The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
 3. IP addresses
 - a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
 - c. The camera shall provide support for both IPv4 and IPv6.
- h. PTZ functionality
1. The camera shall:
 - a. Provide Digital PTZ functionality.
- i. Event functionality
1. The camera shall be equipped with an integrated event functionality, which can be triggered by:

- a. Video Motion Detection
 - b. Live Stream Accessed
 - c. Day/Night Mode
 - d. Camera tampering
 - e. Manual Trigger/Virtual Inputs
 - f. PTZ functionality
 - g. Embedded third party applications
 - h. Edge storage disruption detection
2. Response to triggers shall include:
 - a. Send notification, using HTTP, HTTPS, TCP, SNMP trap or email
 - b. Send images, using FTP, HTTP, HTTPS, network share or email
 - c. Send video clip, using FTP, HTTP, HTTPS, network share or email
 - d. Send SNMP trap message
 - e. Activate/Deactivate IR Illumination
 - f. Recording to local storage and/or network attached storage
 - g. PTZ control functionality
 - h. WDR mode
 3. The camera shall provide memory for pre & post alarm recordings.
- j. Edge storage
 1. The camera shall support continuous and event controlled recording to:
 - a. Local memory added to the cameras microSD-card slot
 - b. Network attached storage, located on the local network
 2. The camera shall be able to detect and notify Edge storage disruptions.
 - k. Protocol
 1. The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, SSH, NTP, CIFS/SMB, Bonjour.
 2. The SMTP implementation shall include support for SMTP authentication.
 - l. Text overlay
 1. The camera shall:
 - a. Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 - b. Provide the ability to apply privacy masks to the image.
 - c. Allow for the overlay of a graphical image, such as a logotype, into the image.
 - m. Security
 1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.

2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
 3. The camera shall support IEEE 802.1X authentication.
 4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
 5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.
- n. API support
1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
 2. The camera shall support relevant ONVIF profiles as defined by the ONVIF Organization.
- o. Embedded applications
1. The camera shall provide a platform allowing the upload of third party applications into the camera.
- p. Installation and maintenance
1. The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
 2. The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
 3. The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
 4. The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
 5. The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
 6. The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
 7. The camera shall provide Remote zoom and Remote focus functionality.
- q. Access log
1. The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
 2. Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
- r. Camera diagnostics
1. The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.

2. The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
 3. The camera shall send a notification when the unit has re-booted and all services are initialized.
- s. Hardware interfaces
1. Network interface
 - a. The camera shall be equipped with one 10BASE-T/100BASE-TX PoE Fast Ethernet-port, using a standard connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
- t. Enclosure
3. The camera shall:
 - a. Be manufactured with an IP66- and NEMA 4X-rated, IK10 impact-resistant casing.
 - b. Be fitted with a dehumidifying membrane.
 - c. Providing encapsulated electronics and captive screws.
- u. Power
1. Power over Ethernet IEEE 802.3af/802.3at Type 1 Class 3
 - a. Max: 10.8 W
 - b. Typical 7.3 W
- v. Environmental
1. Operate in a temperature range of -30 °C to +50 °C (-22 °F to 122 °F).
 2. Operate in a humidity range of 10–100% RH (condensing).

D. 6 MP outdoor-ready dome network camera

1. The network camera shall meet or exceed the following design specifications:
 1. The camera shall operate on an open source and Linux-based platform and include a built-in web server.
 2. The camera shall be equipped with a progressive scan megapixel sensor.
 3. The camera shall provide a removable IR-cut filter, providing day/night functionality.
 4. The camera shall be factory-focused, which removes the need for manual focusing.
 5. The camera shall be manufactured with a repaintable casing.
 6. The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
 7. The camera shall be manufactured with an IP66-, NEMA 250 4X-rated and IK-10 impact-resistant casing with polycarbonate and aluminum hard-coated dome.
 8. The network camera shall meet or exceed the following performance specifications:
 9. Illumination
 10. The camera shall meet or exceed the following illumination specifications:
 11. Color: 0.16 lux at 50 IRE F2.0
 12. B/W: 0.03 lux at 50 IRE F2.0
 13. 0 lux with IR illumination on
 14. Resolution

15. The camera shall be designed to provide at multiple, individually configurable streams in H.264 and Motion JPEG.
16. The camera shall support 360° overview, de-warped panorama, double panorama, corridor and quad views. Up to four individually cropped out and de-warped view areas. The 360° overview can be streamed simultaneously with four view areas or one other de-warped view.
17. The camera shall support video resolutions including:
18. Overview: 2048x2048 to 160x160
19. Panorama: 2560x960 to 192x72
20. Double Panorama: 2560x1920 to 256x144
21. Quad view: 2560x1920 to 256x144
22. View area 1-4, 16:9: 1920x1080 to 256x144, 4:3: 1920x1440 to 320x240
23. Panorama corner left or right: 2368x1184 to 192x72
24. Double panorama corner: 2048x2048 to 320x240
25. Corridor: 2560x1920 to 256x144
26. The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).

2. Encoding

1. The camera shall support the following video encoding algorithms:
2. Motion JPEG encoding with WDR in a selectable range from 1 up to 25/30 frames per second in 360° overview and de-warped views.
3. Motion JPEG encoding without WDR in a selectable range from 1 up to 50/60 frames per second in 360° overview.
4. Baseline Profile H.264 encoding with motion estimation.
5. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC).
6. High Profile H.264 encoding with motion estimation.
7. The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
8. The camera shall in H.264 | H.265 support combining Average Bit Rate (ABR) and Maximum Bit Rate (MBR)
9. The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and selected retention time.
10. The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and the selected retention time.
11. The ABR bitrate algorithm, depending on the bitrate budget and the selected retention time, shall adjust the bitrate to meet the bitrate budget over the whole retention time.
12. The ABR algorithm shall have a method to keep the video quality even during busy periods by allowing the current bitrate to be significantly above the configured average bitrate during significant parts of the retention time.
13. The camera shall in H.264 | H.265 support flexible retention period for Average Bit Rate (ABR) algorithm up to 1 year.

14. When using Average Bit Rate (ABR) the camera shall keep bitrate history up to at least 30 days.
15. The camera shall in H.264 | H.265 support reuse of past Average Bit Rate (ABR) history if a stream is disconnected and the camera reconnects with the same basic stream parameters.
16. When using Average Bit Rate (ABR), the camera shall in H.264 | H.265 support multiple parallel stream with independent ABR-history.
17. The camera shall issue bitrate degradation events when using Average Bit Rate (ABR) if the configuration is predicted to be
18. unrealistic
19. not fulfilling basic quality requirements
20. not fulfilling the bitrate budget.
21. The camera shall provide configurable compression levels.
22. The camera shall support standard baseline profile H.264 with motion estimation.
23. The camera shall support motion estimation in H.264/MPEG-4 Part 10/AVC.
24. The camera shall for its H.264 implementation support scene adaptive bitrate control with automatic dynamic ROI to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.

3. Transmission

1. The camera shall allow for video to be transported over:
 2. HTTP (Unicast)
 3. HTTPS (Unicast)
 4. RTP (Unicast & Multicast)
 5. RTP over RTSP (Unicast)
 6. RTP over RTSP over HTTP (Unicast)
 7. SRTP (Unicast & Multicast)
8. The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
9. Image
 10. The camera shall incorporate automatic and manual white balance.
 11. The camera shall incorporate an electronic shutter operating in the range of 1/100000 s to 2 s.
 12. The camera shall incorporate forensic wide dynamic range functionality, providing up to 120 dB dynamic range.
 13. The camera shall support manually defined values for:
 14. Color level
 15. Brightness
 16. Sharpness
 17. Contrast
 18. The camera shall allow for rotation of the image.
 19. Audio

20. The camera shall support two-way audio connectivity via portcast technology with an accessory audio and I/O interface device.
21. IR Illumination
22. The camera shall be equipped with built-in IR LEDs.
23. The IR LEDs shall have a range of up to 20 m (66 ft)
24. The IR LEDs shall emit light with a wavelength of 850 nm.

3. User Interface

1. Web server
2. The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
3. Optional components downloaded from the camera for specific tasks shall be signed by an organization providing digital trust services, such as Verisign, Inc.
4. Language Specification
5. The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
6. IP addresses
7. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
8. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature.
9. The camera shall provide support for both IPv4 and IPv6.
10. PTZ functionality
11. The camera shall:
 12. Provide digital PTZ functionality of view areas.
 13. Provide preset positions functionality.
 14. Provide digital pan (except panorama at wall mount) and tilt of panorama, corner, corridor and quad views.
 15. Provide a guard tour functionality which allows the dome to automatically move between selected presets using an individual speed and viewing time for each preset.
16. Event functionality
17. The camera shall be equipped with an integrated event functionality, which can be triggered by:
 18. Video Motion Detection
 19. Camera tampering
 20. Manual Trigger/Virtual Inputs
 21. PTZ functionality
 22. Embedded third party applications
 23. Edge storage fail-over recording detection
 24. Open casing

4. Response to triggers shall include event actions:

1. Send notification, using HTTP, HTTPS, TCP, SNMP trap or email
2. Send images, using FTP, SFTP, HTTP, HTTPS, network share or email
3. Send video clip, using FTP, SFTP, HTTP, HTTPS, network share or email
4. Send SNMP trap message
5. Recording to local storage and/or network attached storage
6. Activate external output
7. PTZ control functionality
8. WDR mode
9. Day and night mode
10. The camera shall provide memory for pre & post alarm recordings.
11. Edge storage
12. The camera shall support continuous and event controlled recording to:
13. Local memory added to the cameras microSD-card slot
14. Network attached storage, located on the local network
15. The camera shall incorporate encryption functionality for the SD card.
16. The camera shall be able to detect and notify edge storage disruptions.

5. Protocol

1. The camera shall incorporate support for at least IPv4, IPv6 USGv6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, Bonjour, UPnP®, SNMP v1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SRTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, SIP, LLDP, HDMI 1.4, MQTT.
2. The SMTP implementation shall include support for SMTP authentication.
3. Text overlay
4. The camera shall:
5. Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
6. Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds.
7. Provide the ability to manually set up and configure privacy masks to the image.
8. Allow for the overlay of a graphical image, such as a logotype, into the image.
9. Security
10. The camera shall support the following:
11. Secure web browsing
12. The use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
13. Restrict access to the built-in web server by usernames and passwords at three different levels.
14. Certificate management

15. Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.

6. Enhanced security features

1. The use of signed firmware validates the firmware's integrity before accepting to install it.
2. The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
3. Authentication
4. IEEE 802.1x (EAP-TLS) authentication.
5. Restrict access to pre-defined IP addresses, commonly known as IP address filtering.
6. Brute force delay protection
7. API support
8. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
9. The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
10. The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
11. Support for Session Initiation Protocol (SIP) for integration with Voice over IP (VoIP) systems, peer to peer or integrated with SIP/PBX

7. Embedded applications

1. The camera shall provide a platform allowing the upload of third-party applications into the camera.
2. Installation and maintenance
3. The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
4. The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
5. The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
6. The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
7. The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
8. The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.

8. Access log

1. The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.

2. The camera shall provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.

9. Camera diagnostics

1. The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
2. The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
3. The camera shall send a notification when the unit has re-booted and all services are initialized.

10. Hardware interfaces

1. Network interface

- a. The camera shall be equipped with one 10BASE-T/100BASE-TX Fast Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).

2. Inputs/Outputs

- a. The camera shall be equipped with one supervised (alarm) input and one digital output, accessible via a removable terminal block. This input shall be configurable to respond to normally open (NO) or normally closed (NC) dry contacts. The output shall be able to provide 12 V DC, 25 mA.
- b. The camera shall provide I/O connectivity via portcast technology with an accessory audio and I/O interface device.

3. Enclosure

- a. The camera shall:
- b. Be manufactured with an IP66, NEMA 4X and IK10 impact-resistant casing in polycarbonate and aluminum.
- c. Be fitted with a dehumidifying membrane.

4. Power

- a. The camera shall provide power over Ethernet IEEE 802.3af/802.3at Type 1 Class 3
- b. Max: 12.95 W
- c. Typical: 7.7 W

5. Environmental

- a. The camera shall:
- b. Operate in a temperature range of -40 °C to 50 °C (-40 °F to 122 °F)
- c. Operate in a maximum temperature (intermittent) of 55 °C (131 °F)
- d. Operate in a humidity range of 10-100% RH (condensing).

E. Fixed mini dome 720p network camera

11. The fixed mini dome network camera shall meet or exceed the following design specifications:

- a. The camera shall operate on an open source; Linux-based platform, and including a built-in web server.
 - b. The camera shall be equipped with a progressive scan megapixel sensor.
 - c. The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
 - d. The camera shall be manufactured with an IP42 water- and dust-resistant, IK08 impact-resistant polycarbonate/ABS casing.
 - e. The camera shall provide a manual 3-axis (pan/tilt/rotation) positioning to allow adjustment for optimum camera rotation and placement.
 - f. The camera shall provide the following camera angle adjustment:
 - 1. Pan $\pm 177^\circ$
 - 2. Tilt $\pm 76^\circ$
 - 3. Rotation $\pm 176^\circ$
 - g. The camera shall provide options for clear and smoked lower dome.
12. The fixed mini dome network camera shall meet or exceed the following performance specifications:
- a. Illumination
 - 1. The camera shall meet or exceed the following illumination specifications:
 - a. 0.25 lux in color
 - b. Resolution
 - 1. The camera shall be designed to provide at least two video streams in HDTV 720p (1280x720) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264 or Motion JPEG.
 - 2. The camera shall support video resolutions including:
 - a. 1280x720 (HDTV 720p)
 - b. 320x240
 - 3. The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).
 - c. Encoding
 - 1. The camera shall support the following video encoding algorithms:
 - a. Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second in all resolutions.
 - b. Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
 - c. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second.
 - d. Support High Profile H.264 encoding with motion estimation up to 25/30 frames per second.
 - e. Support H.264 with automatic scene adaptive bitrate control in up to 25/30 frames per second.
 - 2. The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.

3. The camera shall in H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate speaks the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
 4. The camera shall provide configurable compression levels.
 5. Support standard baseline profile H.264 with motion estimation.
 6. Support motion estimation in H.264/MPEG-4 Part 10/AVC.
 7. The camera shall have Zipstream technology, an H.264 implementation that supports scene adaptive bitrate control with the following capabilities to lower bandwidth and storage.
 - a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
 - b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
 - c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements
- d. Transmission
1. The camera shall allow for video to be transported over:
 - a. HTTP (Unicast)
 - b. HTTPS (Unicast)
 - c. RTP (Unicast & Multicast)
 - d. RTP over RTSP (Unicast)
 - e. RTP over RTSP over HTTP (Unicast)
 2. The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- e. Image
1. The camera shall incorporate Automatic and Manual White Balance.
 2. The camera shall incorporate an electronic shutter operating in the range of 1/32500 s to 1/5 s.
 3. The camera shall incorporate Wide Dynamic Range functionality.
 4. The camera shall provide backlight compensation functionality.
 5. The camera shall support manually defined values for:
 - a. Color level
 - b. Brightness
 - c. Sharpness
 - d. Contrast
 6. The camera shall allow for rotation of the image in steps of 90°.
- f. User Interface
1. Web server
 - a. The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - b. Optional components downloaded from the camera for specific tasks, e.g. Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.

2. Language Specification
 - a. The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
3. IP addresses
 - a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
 - c. The camera shall provide support for both IPv4 and IPv6.
- g. Event functionality
 1. The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a. Video Motion Detection
 - b. Live Stream Accessed
 - c. Camera tampering
 - d. Manual Trigger/Virtual Inputs
 - e. Embedded third party applications
 - f. Edge storage disruption detection
 2. Response to triggers shall include:
 - a. Send notification, using HTTP, HTTPS, TCP, SNMP trap or email
 - b. Send images, using FTP, HTTP, HTTPS, network share or email
 - c. Send video clip, using FTP, HTTP, HTTPS, network share or email
 - d. Recording to local storage and/or network attached storage
 - e. Overlay text
 3. The camera shall provide memory for pre & post alarm recordings.
- h. Edge storage
 1. The camera shall support continuous and event controlled recording to:
 - a. Local memory added to the cameras SD-card slot
 - b. Network attached storage, located on the local network
 2. The camera shall be able to detect and notify Edge storage disruptions.
- i. Protocol
 1. The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, SSH, NTP, CIFS/SMB, Bonjour.
 2. The SMTP implementation shall include support for SMTP authentication.
- j. Text overlay
 1. The camera shall:
 - a. Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 - b. Provide the ability to apply privacy masks to the image.

c. Allow for the overlay of a graphical image, such as a logotype, into the image.

k. Security

1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
3. The camera shall support IEEE 802.1X authentication.
4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.

l. API support

1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
2. The camera shall support relevant ONVIF profiles as defined by the ONVIF Organization.

m. Embedded applications

1. The camera shall provide a platform allowing the upload of third party applications into the camera.

n. Installation and maintenance

1. The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
2. The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
3. The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
4. The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
5. The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
6. The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.

o. Access log

1. The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
2. Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.

p. Camera diagnostics

1. The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
2. The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
3. The camera shall send a notification when the unit has re-booted and all services are initialized.

q. Hardware interfaces

1. Network interface

- a. The camera shall be equipped with one 10BASE-T/100BASE-TX PoE Fast Ethernet-port, using a standard male RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).

r. Enclosure

1. The camera shall:

- a. Be manufactured with an IP42 water- and dust-resistant, IK08 impact-resistant polycarbonate/ABS casing
- b. Provide encapsulated electronics.

s. Power

1. Power over Ethernet IEEE 802.3af/802.3at Type 1 Class 1

- a. Typical 2.5 W
- b. Max 2.9 W

t. Environmental

1. Operate in a temperature range of 0 °C to +45 °C (+32 °F to 113 °F).
2. Operate in a humidity range of 15–85% RH (non-condensing).

F. HDTV 1080p fixed dome network camera

1. The specified product shall meet or exceed the following design specifications:

- a. The product shall operate on an open source and Linux-based platform, and include a built-in web server.
- b. The product shall be equipped with an IR-sensitive progressive scan megapixel sensor.
- c. The product shall provide a removable IR-cut filter, providing day/night functionality.
- d. The product shall be equipped with a 3.4-8.9 mm varifocal IR-corrected megapixel lens with P-Iris.
- e. The product shall be equipped with remote zoom and focus, providing a horizontal field of view between 100° and 36° and a vertical field of view between 53° and 20°.
- f. The product shall be manufactured with a repaintable casing.
- g. The product shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
- h. The product shall be manufactured with an IP52-rated and IK10 impact-resistant polymer enclosure with dehumidifying membrane.

- i. The product shall provide options for clear and smoked lower dome
- j. The specified product shall meet or exceed the following performance specifications:

2. Illumination

- a. The product shall meet or exceed the following illumination specifications:
- b. 25/30 fps with Forensic WDR
- c. 0.1 lux, F1.8 (color)
- d. 0.02 lux, F1.8 (B/W)
- e. 0 lux with IR illumination on

3. Resolution

- a. The product shall be designed to provide video streams in HDTV 1080p (1920x1080) at up to 60 frames per second (60Hz mode) or 50 frames per second (50Hz mode) using H.264 or Motion JPEG.
- b. The product shall provide 2 individually cropped out view areas.
- c. The product shall support video resolutions including:
- d. 1920x1080 (HDTV 1080p)
- e. 1280x720 (HDTV 720p)
- f. 1440x1080 (4:3)
- g. 1440x900 (16:10)
- h. The product shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).

4. Encoding

- a. The product shall provide independently configured simultaneous H.264, H.265 and Motion JPEG streams.
- b. The product shall provide configurable compression levels.
- c. The product shall support standard baseline profile with motion estimation.
- d. The product shall support motion estimation in H.264/MPEG-4 Part 10/AVC.
- e. The product shall support the following video encoding algorithms:
- f. Motion JPEG encoding in a selectable range from 1 up to 50/60 frames per second.
- g. Baseline Profile H.264 encoding with motion estimation in up to 50/60 frames per second.
- h. Main Profile H.264 and H.265 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 50/60 frames per second.
- i. High Profile H.264 encoding with motion estimation up to 50/60 frames per second.
- j. The camera shall in H.264 and H.265 support combining Average Bit Rate (ABR) and Maximum Bit Rate (MBR)
- k. The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and selected retention time.
- l. The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and the selected retention time.
- m. The ABR bitrate algorithm, depending on the bitrate budget and the selected retention time, shall adjust the bitrate to meet the bitrate budget over the whole retention time.

- n. The ABR algorithm shall have a method to keep the video quality even during busy periods by allowing the current bitrate to be significantly above the configured average bitrate during significant parts of the retention time.
 - o. The camera shall in H.264 and H.265 support flexible retention period for Average Bit Rate (ABR) algorithm up to 1 year.
 - p. When using Average Bit Rate (ABR) the camera shall keep bitrate history up to at least 30 days.
 - q. The camera shall in H.264 and H.265 support reuse of past Average Bit Rate (ABR) history if a stream is disconnected and the camera reconnects with the same basic stream parameters.
 - r. When using Average Bit Rate (ABR), the camera shall in H.264 and H.265 support multiple parallel stream with independent ABR-history.
 - s. The camera shall issue bitrate degradation events when using Average Bit Rate (ABR) if the configuration is predicted to be
 - 1. unrealistic
 - 2. not fulfilling basic quality requirements
 - 3. not fulfilling the bitrate budget
 - t. The product shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage:
 - u. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
 - v. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
 - w. Automatic dynamic Frames per Second to lower bandwidth and storage requirements
5. Transmission
- a. The product shall allow for video to be transported over:
 - b. HTTP (Unicast)
 - c. HTTPS (Unicast)
 - d. RTP (Unicast & Multicast)
 - e. RTP over RTSP (Unicast)
 - f. RTP over RTSP over HTTP (Unicast)
 - g. SRTP (Unicast & Multicast)
 - h. The product shall support Quality of Service (QoS) to be able to prioritize traffic.
6. Image
- a. The product shall incorporate automatic and manual white balance.
 - b. The product shall incorporate an electronic shutter operating in the range of 1/66500 s to 2 s.
 - c. The product shall incorporate capture mode with the following settings:
 - d. HDTV 1080p (1920x1080) with WDR: 25/30 fps (50/60 Hz)
 - e. HDTV 1080p (1920x1080) without WDR: Up to 50/60 fps (50/60 Hz)
 - f. The product shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.

- g. The product shall support manually defined values for:
 - 1. Saturation
 - 2. Brightness
 - 3. Sharpness
 - 4. Contrast
- h. The product shall incorporate a function to manually correct barrel distortion, by using a slider to correct distortion in the image.
- i. The product shall incorporate a function for optimization of low light behavior.
- j. The product shall allow for rotation of the image in steps of 90°.
- k. The product shall incorporate automatic defog functionality.

7. Audio

- a. The product shall support two-way full duplex audio:
- b. Input sources
- c. External microphone
- d. External line device
- e. External digital line device with ring power
- f. Output sources
- g. External line device
- h. The camera shall support automatic gain control.

8. Encoding

- a. The product shall support:
- b. AAC LC at 8/16/32/44.1/48 kHz
- c. 48-bit LPCM
- d. G.711 PCM at 8 kHz
- e. G.726 ADPCM at 8 kHz
- f. Opus at 8/16/48kHz
- g. The unit shall support SIP for integration with VoIP, peer-to-peer or integrated into SIP/PBX.

9. IR Illumination

- a. The product shall be equipped with built-in IR LEDs with adjustable illumination intensity and with a range of up to 40 m (130 ft), with a wavelength of 850 nm.

10. User Interface

- a. Web server
- b. The product shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
- c. Optional components downloaded from the product for specific tasks shall be signed by an organization providing digital trust services.
- d. Language Specification
 - 1. The product shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.

11. IP addresses

- a. The product shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
- b. The product shall allow for automatic detection of the product based on UPnP and Bonjour when using a computer with an operating system supporting this feature.
- c. The product shall provide support for both IPv4 and IPv6.

12. PTZ functionality

- a. The product shall:
- b. Provide digital PTZ functionality.
- c. Provide preset positions functionality.

13. Event functionality

- a. The product shall be equipped with an integrated event functionality:
- b. Audio
- c. Audio detection
- d. Device status
- e. Operating temperature
- f. IP address
- g. Network lost
- h. Ringpower overcurrent protection
- i. Storage failure
- j. System ready
- k. Edge storage
- l. Recording ongoing
- m. Storage disruption
- n. I/O
- o. Digital input
- p. Manual trigger
- q. Virtual inputs
- r. PTZ
- s. Malfunctioning
- t. Movement
- u. Preset position reached
- v. Ready
- w. Scheduled and recurring
- x. Video
- y. Average bitrate degradation
- z. Day-night mode
- aa. Live stream open
- bb. Tampering

- cc. Response to triggers shall include event actions:
- dd. Play audio clips
- ee. Day-night mode
- ff. Defog
- gg. Guard tours
- hh. I/O
- ii. Upload of images and video clips: FTP, HTTP, HTTPS, SFTP, email or network share
- jj. IR illumination
- kk. Send notification: HTTP, HTTPS, TCP and email
- ll. Overlay text
- mm. Preset positions
- nn. Prioritized text
- oo. Recordings
- pp. SNMP trap messages
- qq. Status LED

14. WDR mode

- a. The product shall provide memory for pre- and post-alarm recordings.
- b. Edge storage
- c. The product shall support continuous and event controlled recording to:
- d. Local memory added to the products microSD-card slot
- e. Network attached storage, located on the local network
- f. The product shall incorporate encryption functionality for the SD card.
- g. The product shall be able to detect and notify edge storage disruptions.

15. Protocol

- a. The product shall incorporate support for at least IPv4, IPv6 USGv6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMP v1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SRTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, SIP, LLDP, MQTT.
- b. The SMTP implementation shall include support for SMTP authentication.

16. Text overlay

- a. The product shall:
- b. Provide embedded on-screen text with support for date & time, and a customer-specific text, product name, of at least 45 ASCII characters.
- c. Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds.
- d. Provide the ability to manually set up and configure privacy masks to the image.
- e. Allow for the overlay of a graphical image, such as a logotype, into the image.
- f. Security
- g. The product shall support the following:
- h. Secure web browsing

- i. The use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
- j. Restrict access to the built-in web server by usernames and passwords at three different levels.

17. Certificate management

- a. Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
- b. Enhanced security features
- c. The use of signed firmware validates the firmware's integrity before accepting to install it.
- d. The use of a secure boot process, based on the use of signed firmware, ensures that the product can boot only with authorized firmware.

18. Authentication

- a. IEEE 802.1X authentication.
- b. Restrict access to pre-defined IP addresses, commonly known as IP address filtering.
- c. Brute force delay protection
- d. Long-Term Supported (LTS) firmware
- e. The manufacturer must provide LTS firmware that only contains corrections for critical bugs, security flaws and performance issues.
- f. The device should maintain cybersecurity without introducing any significant functional changes or affecting any existing integrations.

19. System integration

- a. The product shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third-party applications.
- b. The product shall conform to ONVIF profile G as defined by the ONVIF Organization.
- c. The product shall conform to ONVIF profile S as defined by the ONVIF Organization.
- d. The product shall conform to ONVIF profile T as defined by the ONVIF Organization.
- e. Support for Session Initiation Protocol (SIP) for integration with Voice over IP (VoIP) systems, peer to peer or integrated with SIP/PBX

20. Analytics

- a. The product shall provide a platform allowing the upload of third-party applications into the camera.
- b. The camera shall support advanced video analytics capabilities with a built-in hardware-accelerated real-time object detect engine, capable of automatically detecting several simultaneously visible objects from a set of pre-trained object categories (such as vehicles and people).

21. Installation and maintenance

- a. The product shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the products' configuration.

- b. The product shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
- c. The product shall allow updates of the software (firmware) over the network, using FTP or HTTP.
- d. The product shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
- e. The product shall accept external time synchronization from an NTP (Network Time Protocol) server.
- f. The product shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
- g. The product shall provide remote zoom and remote focus functionality.

22. Access log

- a. The product shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
- b. The product shall provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
- c. Camera diagnostics
- d. The product shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the product's operational status and provide information about power, communication with receiver, the network status and the product status.
- e. The product shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
- f. The product shall send a notification when the unit has rebooted and all services are initialized.

23. Hardware interfaces

- a. Network interface
 - 1. The product shall be equipped with one 10BASE-T/100BASE-TX Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
- b. Inputs/Outputs
 - 1. The product shall be equipped with one digital (alarm) input and one digital output, accessible via a removable terminal block. This input shall be configurable to respond to normally open (NO) or normally closed (NC) dry contacts. The output shall be able to provide 12 V DC, 15 mA.
- c. Audio
 - 1. The product shall be equipped with one 4-pin 2.5 mm (0.098 in) terminal block for audio in and out.

24. Enclosure

- a. The product shall:
 - 1. Be manufactured with an IP52-rated and IK10-resistant polymer enclosure.

2. Be fitted with a dehumidifying membrane.

25. Power

- a. The product shall provide power over Ethernet IEEE 802.3af/802.3at Type 1 Class 3
- b. Max: 10.7 W
- c. Typical: 6.4 W
- d. Environmental
- e. The product shall:
- f. Operate in a temperature range of 0 °C to +50 °C (32 °F to 122 °F)
- g. Operate in a humidity range of 10–85% RH (non-condensing).

G. 1080p PTZ network camera

26. The network camera shall meet or exceed the following design specifications:

- a. The camera shall operate on an open source; Linux-based platform, and including a built-in web server.
- b. The camera shall provide a removable IR-cut filter, providing day/night functionality.
- c. The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC UHS-I memory card expansion.
- d. The camera shall be manufactured with an IP66, NEMA 4X and IK09-rated repaintable plastic casing.
- e. The camera shall provide options for clear and smoked lower dome.

27. The network camera shall meet or exceed the following performance specifications:

a. Illumination

1. The camera shall meet or exceed the following illumination specifications:

- a. 0.45 lux at 30 IRE F1.6 (Color)
- b. 0.01 lux at 30 IRE F1.6 (B/W)
- c. 0.55 lux at 50 IRE F1.6 (Color)
- d. 0.01 lux at 50 IRE F1.6 (B/W)

b. Resolution

1. The camera shall be designed to provide video streams in HDTV 1080p (1920x1080) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264 or Motion JPEG.

2. The camera shall support video resolutions including:

- a. 1920x1080 (HDTV 1080p)
- b. 1280x720 (HDTV 720p)

c. Encoding

1. The camera shall support the following video encoding algorithms:

- a. Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second in all resolutions.
- b. Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.

- c. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second.
 - d. Support High Profile H.264 encoding with motion estimation up to 25/30 frames per second.
 - e. Support H.264 with automatic scene adaptive bitrate control in up to 25/30 frames per second.
- 2. The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
- 3. The camera shall in H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate spikes the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
- 4. The camera shall provide configurable compression levels.
- 5. Support standard baseline profile H.264 with motion estimation.
- 6. Support motion estimation in H.264/MPEG-4 Part 10/AVC.
- 7. The camera shall have Zipstream technology, an H.264 implementation that supports scene adaptive bitrate control with the following capabilities to lower bandwidth and storage.
 - a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
 - b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
 - c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements.
- d. Transmission
 - 1. The camera shall allow for video to be transported over:
 - a. HTTP (Unicast)
 - b. HTTPS (Unicast)
 - c. RTP (Unicast & Multicast)
 - d. RTP over RTSP (Unicast)
 - e. RTP over RTSP over HTTP (Unicast)
 - 2. The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- e. Image
 - 1. The camera shall incorporate Automatic and Manual White Balance.
 - 2. The camera shall incorporate an electronic shutter operating in the range of 1/66500s to 2s.
 - 3. The camera shall incorporate Wide Dynamic Range - Forensic Capture functionality.
 - 4. The camera shall support manually defined values for:
 - a. Color level
 - b. Brightness
 - c. Sharpness
 - d. Contrast
 - 5. The camera shall incorporate a function for optimization of low light behavior.

f. Audio

1. The camera shall support two-way full duplex audio:
2. Input sources
 - a. External microphone (balanced/unbalanced)
 - b. External line device
3. Output sources
 - a. External line device
4. Encoding
 - a. The camera shall support:
 1. AAC LC at 8/16/32 kHz
 2. G.711 PCM at 8 kHz
 3. G.726 ADPCM 8 kHz

g. User Interface

1. Web server
 - a. The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - b. Optional components downloaded from the camera for specific tasks, e.g. Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
2. Language Specification
 - a. The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
3. IP addresses
 - a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
 - c. The camera shall provide support for both IPv4 and IPv6.

h. PTZ functionality

1. The camera shall:
 - a. Be equipped with accurate pan and tilt functionality
 1. Pan: 360°
 2. Tilt: 90°
 - b. Provide pan and tilt speed in a range of:
 1. 1.8° - 150°/sec
 2. 1.8° - 150°/sec
 - c. Provide optical and digital zoom functionality:
 1. Optical zoom: 10x
 2. Digital zoom: 12x

- d. Provide preset positions functionality.
 - e. Provide On-screen directional indicator (OSDI) functionality.
- i. Event functionality
1. The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a. Video Motion Detection
 - b. Audio Detection
 - c. Live Stream Accessed
 - d. Camera tampering
 - e. Manual Trigger/Virtual Inputs
 - f. PTZ functionality
 - g. External input
 - h. Embedded third party applications
 - i. Edge storage disruption detection
 2. Response to triggers shall include:
 - a. Send notification, using HTTP, HTTPS, TCP and SNMP trap
 - b. Send images, using FTP, HTTP, HTTPS, network share or email
 - c. Send video clip, using FTP, HTTP, HTTPS, network share or email
 - d. Send SNMP trap message
 - e. Recording to local storage and/or network attached storage
 - f. Activating external output
 - g. Play audio clip
 - h. PTZ control functionality
 - i. WDR mode
 3. The camera shall provide memory for pre & post alarm recordings.
- j. Edge storage
1. The camera shall support continuous and event controlled recording to:
 - a. Local memory added to the cameras SD-card slot
 - b. Network attached storage, located on the local network
 2. The camera shall incorporate encryption functionality for the SD card.
 3. The camera shall be able to detect and notify Edge storage disruptions.
- k. Protocol
1. The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, FTP, SFTP CIFS/SMB, SMTP, Bonjour, UPnP/TM, SNMP v1/v2c/v3(MIB-II), DNS, DynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH
 2. The SMTP implementation shall include support for SMTP authentication.
- l. Text overlay
1. The camera shall:

- a. Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 - b. Provide the ability to manually set up and configure up to 20 3D privacy masks to the image.
 - c. Allow for the overlay of a graphical image, such as a logotype, into the image.
- m. Security
- 1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 - 2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
 - 3. The camera shall support IEEE 802.1X authentication.
 - 4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
 - 5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.
- n. API support
- 1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
 - 2. The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
 - 3. The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
 - a. For ONVIF profile specifications, see www.onvif.org/
- o. Embedded applications
- 1. The camera shall support the ACAP platform allowing the upload of third party applications into the camera.
- p. Installation and maintenance
- 1. The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
 - 2. The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
 - 3. The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
 - 4. The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
 - 5. The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
 - 6. The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
- q. Access log

1. The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
 2. Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
- r. Camera diagnostics
1. The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
 2. The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
 3. The camera shall send a notification when the unit has re-booted and all services are initialized.
- s. Hardware interfaces
1. Network interface
 - a. The camera shall be equipped with one 100BASE-TX Fast Ethernet-port, using a standard RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
 2. Inputs/Outputs
 - a. The camera shall be equipped with four configurable I/O ports, accessible via a removable terminal block. These inputs/outputs shall be configurable to respond to normally open (NO) or normally closed (NC) dry contacts. The output shall be able to provide 12 V DC, 50 mA
 3. Audio
 - a. The camera shall be equipped with one 3.5 mm jack for line/mic input and one 3.5 mm jack for line output.
 4. Power
 - a. The camera shall be equipped with a removable terminal block providing connectivity for external power.
- t. Enclosure
1. The camera shall:
 - a. Be manufactured with an IP66, NEMA 4X and IK09-rated repaintable plastic casing, polycarbonate (PC) dome
- u. Power
1. Power over Ethernet IEEE 802.3af/802.3at Type 1 Class 3
 - a. Max: 12.95 W
 - b. Typical: 6.6 W
 2. 20 – 28 V DC
 - a. Max: 13 W
 - b. Typical: 6.3
- v. Environmental

1. The camera shall:
 - a. Operate in a temperature range of -20 °C to 50 °C (-4 °F to 122 °F)
 - b. Operate in a humidity range of 15-100% RH (condensing)

H. PTZ dome 720p network camera

28. The PTZ dome network camera shall meet or exceed the following design specifications:

- a. The camera shall operate on an open source; Linux-based platform, and including a built-in web server.
- b. The camera shall be equipped with an IR-sensitive progressive scan megapixel sensor.
- c. The camera shall provide a removable IR-cut filter, providing day/night functionality.
- d. The camera shall be equipped with a varifocal lens with auto-iris and autofocus.
- e. The camera shall provide local video storage utilizing a SDHC/SDXC UHS-I memory card expansion.
- f. The camera shall be manufactured with an IP66-, IK10- and NEMA 4X-rated metal casing (aluminum).
- g. The camera shall be manufactured with a repaintable metal casing.

29. The PTZ dome network camera shall meet or exceed the following performance specifications:

a. Illumination

1. The camera shall meet or exceed the following illumination specifications:

- a. 0.2 lux at 30 IRE F1.6 (color)
- b. 0.01 lux at 30 IRE F1.6 (B/W)
- c. 0.25 lux at 50 IRE F1.6 (color)
- d. 0.02 lux at 50 IRE F1.6 (B/W)

b. Resolution

1. The camera shall be designed to provide at least two video streams in HDTV 720p (1280x720) at up to 60 frames per second (60Hz mode) or 50 frames per second (50Hz mode) using H.264 or Motion JPEG.

2. The camera shall support video resolutions including:

- a. 1280x720 (HDTV 720p)
- b. 800x450
- c. 480x270
- d. 320x180

c. Encoding

1. The camera shall support the following video encoding algorithms:

- a. Motion JPEG encoding in a selectable range from 1 up to 50/60 frames per second.
- b. Baseline Profile H.264 encoding with motion estimation in up to 50/60 frames per second.
- c. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 50/60 frames per second.
- d. High Profile H.264 encoding with motion estimation up to 50/60 frames per second.
- e. H.264 with automatic scene adaptive bitrate control.

2. The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
 3. The camera shall in H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate spikes the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
 4. The camera shall provide configurable compression levels.
 5. Support standard baseline profile H.264 with motion estimation.
 6. Support motion estimation in H.264/MPEG-4 Part 10/AVC.
 7. The camera shall have Zipstream technology, an H.264 implementation that supports scene adaptive bitrate control with the following capabilities to lower bandwidth and storage.
 - a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
 - b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
 - c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements
- d. Transmission
1. The camera shall allow for video to be transported over:
 - a. HTTP (Unicast)
 - b. HTTPS (Unicast)
 - c. RTP (Unicast & Multicast)
 - d. RTP over RTSP (Unicast)
 - e. RTP over RTSP over HTTP (Unicast)
 2. The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- e. Image
1. The camera shall incorporate Automatic and Manual White Balance.
 2. The camera shall incorporate an electronic shutter operating in the range of 1/45500 to 2 s.
 3. The camera shall incorporate Wide Dynamic Range - Forensic Capture functionality providing up to 120dB dynamic range.
 4. The camera shall provide automatic backlight compensation functionality.
 5. The camera shall support manually defined values for:
 - a. Color level
 - b. Brightness
 - c. Sharpness
 - d. Contrast
 6. The camera shall incorporate a function for optimization of low light behavior.
- f. User Interface
1. Web server
 - a. The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.

- b. Optional components downloaded from the camera for specific tasks, e.g. Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
2. Language Specification
 - a. The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
 3. IP addresses
 - a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
 - c. The camera shall provide support for both IPv4 and IPv6.
- g. PTZ functionality
1. The camera shall:
 - a. Provide more than 255 manually set preset positions.
 - b. Provide a guard tour functionality which allows the dome to automatically move between selected presets using an individual speed and viewing time for each preset.
 - c. Be able to record a custom PTZ tour, operated using an input device such as a joystick, mouse or keyboard, and then use and recall this as a guard tour.
 - d. Provide On-screen directional indicator (OSDI) functionality.
 - e. Be equipped with accurate high-speed pan-tilt functionality with 360° endless pan range and a 180° tilt range.
 - f. Provide focus recall functionality in order to manually set a fixed focus in a predefined area.
 - g. Provide pan speed between 0.1° - 350°/sec.
 - h. Provide tilt speed between 0.1° - 350°/sec.
 - i. Provide 23x optical zoom.
 - j. Provide 12x digital zoom.
- h. Event functionality
1. The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a. Video Motion Detection
 - b. Day/Night Mode
 - c. Live Stream Accessed
 - d. Manual Trigger/Virtual Inputs
 - e. PTZ functionality
 - f. Embedded third party applications
 - g. Edge storage disruption detection
 - h. Shock Detected
 2. Response to triggers shall include:
 - a. Send notification, using HTTP, HTTPS, TCP, SNMP trap or email

- b. Send images, using FTP, HTTP, HTTPS, network share or email
 - c. Send video clip, using FTP, HTTP, HTTPS, network share or email
 - d. Send SNMP trap message
 - e. Recording to local storage and/or network attached storage
 - f. PTZ control functionality
 - g. WDR mode
 - h. Overlay Text
3. The camera shall provide memory for pre & post alarm recordings.
- i. Edge storage
- 1. The camera shall support continuous and event controlled recording to:
 - a. Local memory added to the cameras SD-card slot
 - b. Network attached storage, located on the local network
 - 2. The camera shall be able to detect and notify Edge storage disruptions.
- j. Protocol
- 1. The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, SSH, NTP, CIFS/SMB, Bonjour.
 - 2. The SMTP implementation shall include support for SMTP authentication.
- k. Text overlay
- 1. The camera shall:
 - a. Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 - b. Provide the ability to apply up to 20 individual 3D privacy masks to the image.
 - c. Allow for the overlay of a graphical image, such as a logotype, into the image.
- l. Security
- 1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 - 2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
 - 3. The camera shall support IEEE 802.1X authentication.
 - 4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
 - 5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.
- m. API support
- 1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
 - 2. The camera shall support relevant ONVIF profiles as defined by the ONVIF Organization.

n. Embedded applications

1. The camera shall provide a platform allowing the upload of third party applications into the camera.

o. Installation and maintenance

1. The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
2. The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
3. The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
4. The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
5. The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
6. The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.

p. Access log

1. The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
2. Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.

q. Camera diagnostics

1. The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
2. The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
3. The camera shall send a notification when the unit has re-booted and all services are initialized.

r. Hardware interfaces

1. Network interface

- a. The camera shall be equipped with one 10BASE-T/100BASE-TX PoE Fast Ethernet-port, using a standard RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).

s. Enclosure

1. The camera shall:

- a. Be manufactured with an IP66-, IK10- and NEMA 4X-rated metal casing (aluminum).
- b. Be manufactured with a repaintable metal casing.

t. Power

1. Power over Ethernet Plus IEEE 802.3at Type 2 Class 4
 - a. Max: 20 W
 - b. Typical: 8 W
 - u. Environmental
 1. Operate in a temperature range of -30 °C to 55 °C (-22 °F to 131 °F).
 2. Operate in a humidity range of 10–100% RH (condensing).
- I. 1080p PTZ Dome network camera
30. The PTZ Dome network camera shall meet or exceed the following design specifications:
 - a. The camera shall operate on an open source; Linux-based platform, and including a built-in web server.
 - b. The camera shall be equipped with an IR-sensitive progressive scan sensor.
 - c. The camera shall provide a removable IR-cut filter, providing day/night functionality.
 - d. The camera shall be equipped with a lens providing autofocus and auto-iris functionality.
 - e. The camera shall provide local video storage utilizing a SD/SDHC/SDXC memory card expansion.
 - f. The camera shall be manufactured with an IP66-, IP67-, NEMA 4X- and IK10-rated metal casing (aluminum).
 - g. The camera shall provide options for clear and smoked lower dome.
 31. The PTZ Dome network camera shall meet or exceed the following performance specifications:
 - a. Illumination
 1. The camera shall meet or exceed the following illumination specifications:
 - a. 0.3 lux at 30 IRE F1.6 (color)
 - b. 0.03 lux at 30 IRE F1.6 (B/W)
 - c. 0.5 lux at 50 IRE F1.6 (color)
 - d. 0.04 lux at 50 IRE F1.6 (B/W)
 - b. Resolution
 1. The camera shall be designed to provide at least two video streams in HDTV 1080p (1920x1080) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264 or Motion JPEG.
 2. The camera shall be designed to provide at least two video streams in HDTV 720p (1280x720) at up to 60 frames per second (60Hz mode) or 50 frames per second (50Hz mode) using H.264 or Motion JPEG.
 3. The camera shall support video resolutions including:
 - a. 1920x1080 (HDTV 1080p)
 - b. 1280x720 (HDTV 720p)
 - c. 320x180
 - c. Encoding
 1. The camera shall support the following video encoding algorithms:

- a. Motion JPEG encoding in a selectable range from 1 up to 50/60 frames per second in resolution 1280x720.
 - b. Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second in resolution 1920x1080.
 - c. Baseline Profile H.264 encoding with motion estimation in up to 50/60 frames per second in resolution 1280x720.
 - d. Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second in resolution 1920x1080.
 - e. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 50/60 frames per second in resolution 1280x720.
 - f. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second in resolution 1920x1080.
 - g. Support High Profile H.264 encoding with motion estimation up to 50/60 frames per second in resolution 1280x720.
 - h. Support High Profile H.264 encoding with motion estimation up to 25/30 frames per second in resolution 1920x1080.
 - i. Support H.264 with automatic scene adaptive bitrate control in up to 50/60 frames per second in resolution 1280x720.
 - j. Support H.264 with automatic scene adaptive bitrate control in up to 25/30 frames per second in resolution 1920x1080.
2. The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
 3. The camera shall in H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate speaks the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
 4. The camera shall provide configurable compression levels.
 5. Support standard baseline profile H.264 with motion estimation.
 6. Support motion estimation in H.264/MPEG-4 Part 10/AVC.
 7. The camera shall have Zipstream technology, an H.264 implementation that supports scene adaptive bitrate control with the following capabilities to lower bandwidth and storage.
 - a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
 - b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
 - c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements
- d. Transmission
1. The camera shall allow for video to be transported over:
 - a. HTTP (Unicast)
 - b. HTTPS (Unicast)
 - c. RTP (Unicast & Multicast)
 - d. RTP over RTSP (Unicast)
 - e. RTP over RTSP over HTTP (Unicast)

2. The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- e. Image
1. The camera shall incorporate Automatic and Manual White Balance.
 2. The camera shall incorporate an electronic shutter operating in the range of:
 - a. 1/33000 s to 1/3 s (50 Hz)
 - b. 1/33000 s to 1/4 s (60 Hz)
 3. The camera shall incorporate Wide Dynamic Range - providing up to 120dB dynamic range.
 4. The camera shall support manually defined values for:
 - a. Color level
 - b. Brightness
 - c. Sharpness
 - d. Contrast
 5. The camera shall incorporate a function for optimization of low light behavior.
 6. The camera shall incorporate highlight compensation functionality.
- f. User Interface
1. Web server
 - a. The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - b. Optional components downloaded from the camera for specific tasks shall be signed by an organization providing digital trust services.
 2. Language Specification
 - a. The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
 3. IP addresses
 - a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
 - c. The camera shall provide support for both IPv4 and IPv6.
- g. PTZ functionality
1. The camera shall:
 - a. Provide more than 255 manually set preset positions.
 - b. Provide e-flip functionality, which will automatically rotate the image 180° electronically when following a moving object passing under the camera.
 - c. Provide a guard tour functionality which allows the dome to automatically move between selected presets using an individual speed and viewing time for each preset.
 - d. Be able to record a custom PTZ tour, operated using an input device such as a joystick, mouse or keyboard, and then use and recall this as a guard tour.

- e. Be able to detect and automatically follow moving objects in the cameras field of view.
 - f. Provide On-screen directional indicator (OSDI) functionality.
 - g. Be equipped with accurate high-speed pan-tilt functionality with 360° endless pan range and a 180° tilt range.
 - h. Provide pan and tilt speed between 0.05° - 450°/sec.
 - i. Provide 32x optical zoom.
 - j. Provide 12x digital zoom.
 - k. Provide adjustable zoom speed.
- h. Event functionality
1. The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a. Video Motion Detection
 - b. Live Stream Accessed
 - c. Manual Trigger/Virtual Inputs
 - d. Fan malfunctioning
 - e. Casing Open
 - f. Heater malfunctioning
 - g. Temperature
 - h. PTZ functionality
 - i. Embedded third party applications
 - j. Edge storage disruption detection
 - k. Shock Detected
 2. Response to triggers shall include:
 - a. Send notification, using HTTP, HTTPS, TCP, SNMP trap or email
 - b. Send images, using FTP, HTTP, HTTPS, network share or email
 - c. Send video clip, using FTP, HTTP, HTTPS, network share or email
 - d. Recording to local storage and/or network attached storage
 - e. Day/Night Vision Mode
 - f. PTZ control functionality
 - g. Overlay Text
 3. The camera shall provide memory for pre & post alarm recordings.
- i. Edge storage
1. The camera shall support continuous and event controlled recording to:
 - a. Local memory added to the cameras SD-card slot
 - b. Network attached storage, located on the local network
 2. The camera shall be able to detect and notify Edge storage disruptions.
- j. Protocol
1. The camera shall incorporate support for at least IPv4, IPv6 USGv6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, FTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMP v1/v2c/v3

(MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SRTP, SFTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, NTCIP, LLDP.

2. The SMTP implementation shall include support for SMTP authentication.

k. Text overlay

1. The camera shall:

- a. Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
- b. Provide the ability to apply up to 32 3D privacy masks to the image.
- c. Allow for the overlay of a graphical image, such as a logotype, into the image.

l. Security

1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
3. The camera shall support IEEE 802.1X authentication.
4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.

m. API support

1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
2. The camera shall support relevant ONVIF profiles as defined by the ONVIF Organization.

n. Embedded applications

1. The camera shall provide a platform allowing the upload of third party applications into the camera.

o. Installation and maintenance

1. The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
2. The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
3. The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
4. The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
5. The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.

6. The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
- p. Access log
1. The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
 2. Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
- q. Camera diagnostics
1. The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
 2. The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
 3. The camera shall send a notification when the unit has re-booted and all services are initialized.
- r. Hardware interfaces
1. Network interface
 - a. The camera shall be equipped with one 10BASE-T/100BASE-TX PoE Fast Ethernet-port, using a standard RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
- s. Enclosure
1. The camera shall:
 - a. Be manufactured with an IP66-, IP67-, NEMA 4X- and IK10-rated metal casing (aluminum).
 2. The camera enclosure shall include the following:
 - a. Sunshield
 - b. Temperature sensors
 - c. Heaters
 - d. Fans
- t. Power
1. 100-240 VAC / 50-60 Hz, max 60 W – provided to the camera through the network cable by a separate injector, supplied with the camera.
- u. Environmental
1. Operate in a temperature range of:
 - a. 30 W midspan -20 °C to 50 °C (-4 °F to 122 °F)
 - b. 60 W midspan -50 °C to 50 °C (-58 °F to 122 °F)
 - c. Maximum temperature (intermittent): 60 °C (140 °F)
 2. The camera shall be equipped with Arctic Temperature Control, allowing camera start-up at temperatures down to -40°C (-40°F).
 3. Operate in a humidity range of 10–100% RH (condensing).

J. Four Sensor Degree Camera with optional PTZ

1. The PTZ dome network camera shall meet or exceed the following design specifications:
 - a. The camera shall operate on an open source; Linux-based platform, and including a built-in web server.
 - b. The camera shall be equipped with a progressive scan sensor.
 - c. The camera shall provide local video storage utilizing a SD/SDHC/SDXC memory card expansion.
 - d. The camera shall be manufactured with an IP66- and NEMA 4X-rated, die-casted aluminum casing.
 - e. The camera shall incorporate 4x HDTV 720p cameras, providing full 360° overview.
 - f. The camera shall be designed to be compatible with any AXIS Q60-E model.
 - g. The camera shall be manufactured with exchangeable and tiltable lenses.
2. The PTZ dome network camera shall meet or exceed the following performance specifications:
 - a. Illumination
 1. The camera shall meet or exceed the following illumination specifications:
 - a. 0.3 lux, F2.0 (color)
 - b. Resolution
 1. The camera shall be designed to provide four video streams in HDTV 720p (1280x720) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264 or Motion JPEG.
 2. The camera shall be designed to provide Quad view in up to 1920x1440 resolution.
 3. The camera shall support video resolutions including:
 - a. 1920x1440 (Quad view)
 - b. 1920x1080 (Quad view)
 - c. 1440x1080 (Quad view)
 - d. 1280x960 (Quad view)
 - e. 1280x720 (HDTV 720p)
3. Encoding
 1. The camera shall support the following video encoding algorithms:
 - a. Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second.
 - b. Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
 - c. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second.
 - d. High Profile H.264 encoding with motion estimation up to 25/30 frames per second.
 - e. H.264 with automatic scene adaptive bitrate control in up to 25/30 frames per second.
 2. The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.

3. The camera shall in H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate speaks the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
4. The camera shall provide configurable compression levels.
5. Support standard baseline profile H.264 with motion estimation.
6. Support motion estimation in H.264/MPEG-4 Part 10/AVC.
7. The camera shall have Zipstream technology, an H.264 implementation that supports scene adaptive bitrate control with the following capabilities to lower bandwidth and storage.
 - a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
 - b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
 - c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements

4. Transmission

1. The camera shall allow for video to be transported over:
 - a. HTTP (Unicast)
 - b. HTTPS (Unicast)
 - c. RTP (Unicast & Multicast)
 - d. RTP over RTSP (Unicast)
 - e. RTP over RTSP over HTTP (Unicast)
2. The camera shall support Quality of Service (QoS) to be able to prioritize traffic.

b. Image

1. The camera shall incorporate Automatic and Manual White Balance.
2. The camera shall incorporate an electronic shutter operating in the range of 1/45500 s to 4 s.
3. The camera shall provide backlight compensation functionality.
4. The camera shall support manually defined values for:
 - a. Color level
 - b. Brightness
 - c. Sharpness
 - d. Contrast
5. The camera shall incorporate a function for optimization of low light behavior.

5. User Interface

1. Web server
 - a. The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - b. Optional components downloaded from the camera for specific tasks, e.g. Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
2. Language Specification

- a. The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
3. IP addresses
- a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
 - c. The camera shall provide support for both IPv4 and IPv6.
6. Event functionality
- 1. The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a. Video Motion Detection
 - b. Live Stream Accessed
 - c. Camera tampering
 - d. Fan Malfunctioning
 - e. Manual Trigger/Virtual Inputs
 - f. Embedded third party applications
 - g. Edge storage disruption detection
 - h. Shock Detected
 - 2. Response to triggers shall include:
 - a. Send notification, using HTTP, HTTPS, TCP, SNMP trap or email
 - b. Send images, using FTP, HTTP, HTTPS, network share or email
 - c. Send video clip, using FTP, HTTP, HTTPS, network share or email
 - d. Send SNMP trap message
 - e. Recording to local storage and/or network attached storage
 - f. Overlay Text
 - 3. The camera shall provide memory for pre & post alarm recordings.
7. Edge storage
- 1. The camera shall support continuous and event controlled recording to:
 - a. Local memory added to the cameras SD-card slot
 - b. Network attached storage, located on the local network
 - 2. The camera shall be able to detect and notify Edge storage disruptions.
8. Protocol
- 1. The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, SSH, NTP, CIFS/SMB, Bonjour.
 - 2. The SMTP implementation shall include support for SMTP authentication.
9. Text overlay
- 1. The camera shall:

- a. Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
- b. Provide the ability to apply privacy masks to the image.
- c. Allow for the overlay of a graphical image, such as a logotype, into the image.

10. Security

1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
3. The camera shall support IEEE 802.1X authentication.
4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.

11. API support

1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
2. The camera shall support relevant ONVIF profiles as defined by the ONVIF Organization.

12. Embedded applications

1. The camera shall support the ACAP platform allowing the upload of third party applications into the camera.

13. Installation and maintenance

1. The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
2. The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
3. The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
4. The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
5. The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
6. The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.

14. Access log

1. The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.

2. Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.

15. Camera diagnostics

1. The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
2. The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
3. The camera shall send a notification when the unit has re-booted and all services are initialized.

16. Hardware interfaces

1. Network interface

- a. The camera shall be equipped with one 10BASE-T/100BASE-TX/1000BASE-T PoE Fast Ethernet-port, using a standard RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).
- b. The camera shall be equipped with a RJ45 10BASE-T/100BASE-TX connection port for interconnection with Q60-E camera.
- c. The camera shall be equipped with a RJ45 10BASE-T/100BASE-TX service port.

17. Enclosure

1. The camera shall:
 - a. Be manufactured with an IP66- and NEMA 4X-rated, die-casted aluminum casing.
 - b. Be manufactured with an polycarbonate dome.

18. Power

1. 100-240 VAC / 50-60 Hz, max 60 W – provided to the camera through the network cable by a separate injector, supplied with the camera.
 - a. Max: 18 W
 - b. Typical: 8 W

19. Environmental

1. Operate in a temperature range of -30 °C to 50 °C (-22 °F to 122 °F).
2. Maximum temperature (intermittent): 60 °C (140 °F)
3. Operate in a humidity range of 10–100% RH (condensing).

K Exterior 15MP panoramic network camera

1. The panoramic network camera shall meet or exceed the following design specifications:
 - a. The camera shall operate on an open source and Linux-based platform and include a built-in web server.
 - b. The camera shall be equipped with four progressive scan megapixel sensors.
 - c. The camera shall provide a removable IR-cut filter, providing day/night functionality.
 - d. The camera shall provide flexible positioning of four varifocal camera heads.
 - e. The camera shall provide the following field of view:

- f. 4x 1440p
 - g. Horizontal: 101° - 49°
 - h. Vertical: 54° - 29°
 - i. Diagonal: 116°–58°
 - j. The camera shall provide motorized focus and zoom functionality.
 - k. The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
 - l. The camera shall be manufactured with an IP66-, NEMA 4X- and IK09-rated Die-casted aluminum casing.
2. The camera shall provide:
- a. Pan $\pm 90^\circ$
 - b. Tilt +25 to +95°
 - c. Rotation -5 to 95°
 - d. Twist $\pm 20^\circ$
 - e. The specified product shall meet or exceed the following performance specifications:
 - f. Illumination
 - g. The camera shall meet or exceed the following illumination specifications:
 - h. Color: 0.20 lux at 50 IRE F1.8
 - i. B/W: 0.04 lux at 50 IRE F1.8 lux with IR illumination on
 - j. Resolution
 - k. The camera shall be designed to provide 4x video streams in HDTV 1440p (2560x1440) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264, H265 or Motion JPEG.
 - l. The camera shall support video resolutions including:
 - m. 2560x1440 (QuadHD, 16:9)
 - n. 1920x1080 (HDTV 1080 p)
 - o. 1280x720 (HDTV 720p)
 - p. The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).
3. Encoding
- a. The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
 - b. The camera shall provide configurable compression levels.
 - c. The camera shall support standard baseline profile with motion estimation.
 - d. The camera shall support motion estimation in H.264/MPEG-4 Part 10/AVC.
 - e. The camera shall support the following video encoding algorithms:
 - f. Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second.
 - g. Baseline Profile H.264 and H.265 encoding with motion estimation in up to 25/30 frames per second.
 - h. Main Profile H.264 and H.265 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second.

- i. High Profile H.264 and H.265 encoding with motion estimation up to 25/30 frames per second.
- j. The camera shall in H.264 and H.265 support combining Average Bit Rate (ABR) and Maximum Bit Rate (MBR)
- k. The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and selected retention time.
- l. The camera shall be able to deliver predictable storage using Average Bit Rate (ABR) bitrate controlling algorithm based on a bitrate budget and the selected retention time.
- m. The ABR bitrate algorithm, depending on the bitrate budget and the selected retention time, shall adjust the bitrate to meet the bitrate budget over the whole retention time.
- n. The ABR algorithm shall have a method to keep the video quality even during busy periods by allowing the current bitrate to be significantly above the configured average bitrate during significant parts of the retention time.
- o. The camera shall in H.264 and H.265 support flexible retention period for Average Bit Rate (ABR) algorithm up to 1 year.
- p. When using Average Bit Rate (ABR) the camera shall keep bitrate history up to at least 30 days.
- q. The camera shall in H.264 and H.265 support reuse of past Average Bit Rate (ABR) history if a stream is disconnected and the camera reconnects with the same basic stream parameters.
- r. When using Average Bit Rate (ABR), the camera shall in H.264 and H.265 support multiple parallel stream with independent ABR-history.
- s. The camera shall issue bitrate degradation events when using Average Bit Rate (ABR) if the configuration is predicted to be
 - a. unrealistic
 - b. not fulfilling basic quality requirements
 - c. not fulfilling the bitrate budget

4. Transmission

- a. The camera shall allow for video to be transported over:
 - b. HTTP (Unicast)
 - c. HTTPS (Unicast)
 - d. RTP (Unicast & Multicast)
 - e. RTP over RTSP (Unicast)
 - f. RTP over RTSP over HTTP (Unicast)
- g. The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- h. Image
 - i. The camera shall incorporate automatic and manual white balance.
 - j. The camera shall incorporate an electronic shutter operating in the range of 1/66500s to 1/5s.
 - k. The camera shall incorporate capture mode with the following settings:
 - l. HDTV 1440p 25/30 fps
 - m. The camera shall support wide dynamic range functionality at 110dB.

- n. The camera shall support manually defined values for:
 - o. Saturation
 - p. Brightness
 - q. Sharpness
 - r. Contrast
 - s. The camera shall incorporate a function for optimization of low light behavior.
 - t. The camera shall allow for rotation of the image in steps of 90°.
5. IR illumination
- a. The camera shall be equipped with built-in IR LEDs, with a range of up to 15 m (50 ft) with a wavelength of 850 nm.
6. User interface
- a. Web server
 - b. The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - c. Optional components downloaded from the camera for specific tasks shall be signed by an organization providing digital trust services.
 - d. Language Specification
 - e. The camera shall provide a function for altering the language of the user interface and shall include support for at least 10 different languages.
 - f. IP addresses
 - g. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - h. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature.
 - i. The camera shall provide support for both IPv4 and IPv6.
7. Event functionality
- a. The camera shall be equipped with an integrated event functionality:
 - b. Device status
 - c. IP address
 - d. Response to triggers shall include event actions:
 - e. Record video: microSD card and network share
 - f. Upload of images and video clips: FTP, SFTP, HTTP, HTTPS, email or network share
 - g. Send notification: email, HTTP, HTTPS, TCP and SNMP trap
 - h. Overlay text
 - i. Day and night mode
8. Storage
- a. The camera shall support continuous and event-controlled recording to:
 - b. Local memory added to the cameras microSD-card slot
 - c. Network attached storage, located on the local network

- d. The camera shall incorporate encryption functionality for the SD card.
- e. The camera shall be able to detect and notify edge storage disruptions.

9. Protocol

- a. The camera shall incorporate support for at least IPv4, IPv6 USGv6, HTTP, HTTPS, SSL/TLS , QoS Layer 3 DiffServ, FTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMP v1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SFTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, MQTT.
- b. The SMTP implementation shall include support for SMTP authentication.

10. Text overlay

- a. The camera shall:
- b. Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
- c. Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds.
- d. Provide the ability to manually set up and configure privacy masks to the image.
- e. Allow for the overlay of a graphical image, such as a logotype, into the image.

11. Security

- a. The camera shall support the following:
- b. Secure web browsing
- c. The use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
- d. Restrict access to the built-in web server by usernames and passwords at three different levels.

12. Certificate management

- a. Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.

13. Enhanced security features

- a. The use of signed firmware validates the firmware's integrity before accepting to install it.

14. Authentication

- a. IEEE 802.1x (EAP-TLS) authentication.
- b. Restrict access to pre-defined IP addresses, commonly known as IP address filtering.
- c. Brute force delay protection

15. Firmware support

- a. The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
- b. The device should maintain high-level cybersecurity without introducing any significant functional changes or affecting any existing integrations.

16. API support

- a. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third-party applications.
- b. The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
- c. The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
- d. Embedded applications
- e. The camera shall provide a platform allowing the upload of third-party applications into the camera.

17. Installation and maintenance

- a. The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
- b. The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
- c. The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
- d. The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
- e. The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
- f. The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
- g. The camera shall provide remote zoom and remote focus functionality.

18. Access log

- a. The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
- b. The camera shall provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.

19. Camera diagnostics

- a. The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
- b. The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
- c. The camera shall send a notification when the unit has rebooted and all services are initialized.

20. Hardware interfaces

a. Network interface

- 1. The camera shall be equipped with one 10BASE-T/100BASE-TX Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).

21. Enclosure

- a. The camera shall:
- b. Be manufactured with an IP66-, IP67-, NEMA 4X-rated, IK09 impact-resistant, aluminum and plastic casing.
- c. Be fitted with a polycarbonate hard-coated dome with a (PC/ASA) sunshield.

22. Power

- a. The camera shall provide Power over Ethernet (PoE) IEEE 802.3at Type 2 Class 4
- b. With IR illumination on:
 - c. Max: 25.5 W
 - d. Typical: 16.3 W
- e. With IR illumination off:
 - f. Max: 25.5 W
 - g. Typical: 10.7 W
- h. Environmental
- i. The camera shall:
 - j. Operate in a temperature range of -30 °C to 50 °C (-22 °F to 112 °F)
 - k. Operate in a humidity range of 10-100% RH (condensing)

Part 2 Execution

2.01 Installation

1. The Contractors or subcontractors' main resources within the project shall carry proper professional certification issued by the manufacturer and verified by a third party organization to confirm sufficient product and technology knowledge.
2. The Contractor shall carefully follow instructions in documentation provided by the manufacturer to ensure all steps have been taken to provide a reliable, easy-to-operate system.
3. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.
4. All firmware found in products shall be the latest and most up-to-date provided by the manufacturer, or of a version as specified by the provider of the Video Management Application (VMA) or Network Video Recorder (NVR).
5. All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.
6. A proper installation shall meet NEC (National Electrical Code – US only) per the guidelines of that year's revision. When properly installed equipment meets Low Voltage, Class 2 classification of the NEC.

END OF SECTION

Panasonic IP Cameras – PTZ Dome Camera

PART 1 GENERAL

The CCTV cameras installed at City of XXXX sites are to be manufactured by Panasonic. The system integrator providing the equipment will ensure that all units are in compliance with the general requirements listed in section 2.4 of this document.

1.01 SUMMARY

1.02 WARRANTY

- A. Provide manufacturer's standard warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Panasonic Company
- B. Provide Video Surveillance Camera from single source manufacturer

2.2 PANASONIC WV-X6531N PTZ DOME NETWORK CAMERA

A. GENERAL CHARACTERISTICS

1. The PTZ Dome Camera shall deliver H.265 stream and H.264 stream.
2. The PTZ Dome Camera shall produce a resolution of 1,920 x 1,080 pixels (Full HD 1080p) at up to 60 fps with a 16:9 aspect ratio.
3. The PTZ Dome Camera shall produce a resolution of 2,048 x 1,536 pixels at 30fps with a 4:3 aspect ratio.
4. The PTZ Dome Camera shall utilize an approximate 1/2.8-inch type high sensitivity MOS image sensor.
5. The PTZ Dome Camera shall be equipped with 40 times optical zoom.
6. The PTZ Dome Camera shall feature an image stabilization to capture stable images even when installing on the plenty-vibration place.
7. The PTZ Dome Camera shall feature a 144dB wide dynamic range based on Enhanced Super Dynamic and Adaptive Black Stretch technology (ABS).
8. The PTZ Dome Camera shall produce a color image with a minimum illumination of 0.015 lux and a monochrome image with 0.001 lux at F1.6, maximum shutter of 1/30s and High gain mode.

9. The PTZ Dome Camera shall be equipped with a special coated cover for increasing the operational utility of outdoor cameras in rain weather.
10. The PTZ Dome Camera shall generate multiple simultaneous video streams of up to four (4) H.265 (Main profile) or H.264 (High profile) streams and JPEG streams.
11. The PTZ Dome Camera shall be equipped with intelligent auto mode, the technology for shooting license plate and person's face more clearly.
12. The PTZ Dome Camera shall be equipped with GOP control and Smart Facial coding which control an image quality of a stationary area, a moving area and a face, as bitrate reducing technology.
13. The PTZ Dome Camera shall produce encrypted stream.
14. The PTZ Dome Camera shall realize SSL / TLS communication with CA certificate.
15. A user shall be able to view video on a PC using a browser.
16. A user shall be able to view video on a smartphone and tablet using viewer software for iPhone and Android.
17. The PTZ Dome Camera shall offer Video Motion Detection (VMD) with four (4) programmable detection areas, 15 steps sensitivity level and 10 steps detection size.
18. The PTZ Dome Camera shall offer an optional vehicle incident detection function which provides wrong-way detection and stopped vehicle detection.
19. The PTZ Dome Camera shall offer an optional intelligent VMD (i-VMD) function which provides intruder detection, loitering detection, direction detection, scene change detection, object detection and cross line detection.
20. The PTZ Dome Camera shall offer an optional face detection function.
21. The PTZ Dome Camera shall have Fog compensation function.
22. The PTZ Dome Camera shall have High light compensation (HLC) function.
23. The PTZ Dome Camera shall have Super Chroma Compensation (SCC) which realizes a better color reproducibility in the low illumination.
24. The PTZ Dome Camera shall provide up to thirty-two (32) areas of electronic privacy masking.
25. The PTZ Dome Camera shall offer the prioritized stream control which transmits a video stream to a specified client PC or recorder preferentially.

26. The PTZ Dome Camera shall have an SD memory card slot that supports SD, SDHC and SDXC memory card for local storage.
27. The PTZ Dome Camera shall offer full-duplex bi-directional audio communication capability between the camera and monitoring site.
28. The PTZ Dome Camera shall have five (5) alarm sources of terminal input, VMD, command alarm, audio detection alarm and auto track alarm that activate the processes such as SDXC/ SDHC/SD memory recording, E-mail notification, HTTP alarm notification, Indication on browser, FTP image transfer and Panasonic alarm protocol output.
29. The PTZ Dome Camera shall conform to the ONVIF profile S and profile G.

B. CAMERA

1. Image Sensor 1/2.8-inch type MOS image sensor
2. Scanning Mode Progressive
3. Minimum Illumination
 - a. Color 0.015 lux (F1.6, Maximum shutter: Max. 1/30s, Gain: On(11))
 - b. B/W 0.001 lux (F1.6, Maximum shutter: Max. 1/30s, Gain: On(11))
4. Day & Night IR Cut filter Removal
5. Dynamic Range 144 dB typ. (Super Dynamic: On)

C. Lens

1. Focal Length 4.25 ~ 170mm (5/32 ~ 6-11/16 inches)
2. Max. Aperture Ratio 1 : 1.6 (WIDE) ~ 1 : 4.95 (TELE)
3. Angular Field of View
 - a. 16:9 aspect ratio H: 2.1° (TELE) - 65° (WIDE)
V: 1.2° (TELE) - 39° (WIDE)
 - b. 4:3 aspect ratio H: 1.6° (TELE) - 51° (WIDE)
V: 1.2° (TELE) - 39° (WIDE)

D. VIDEO

1. Compression Format H.265, H.264, JPEG
2. Image Resolution
 - a. 16:9 aspect ratio (2 mega pixel mode)
1,920 x 1,080 / 1,280 x 720 / 640 x 360 / 320 x 180 (30/60fps)
 - b. 4:3 aspect ratio (3 mega pixel mode)
2,048 x 1,536 / 1,280 x 960 / 800 x 600 / 640 x 480 / 400 x 300 /
320 x 240 (30fps)
3. H.265 / H.264
 - a. Transmission Mode Constant bitrate, VBR, Frame rate priority, Best effort
 - b. Frame Rate 1 / 3 / 5 / 7.5 / 10 / 12 / 15 / 20 / 30 / 60 fps
 - c. Bit Rate/Client 64 / 128 / 256 / 384 / 512 / 768 / 1,024 / 1,536 / 2,048 / 3,072 /
4,096 / 6,144 / 8,192 / 10,240 / 12,288 / 14,336 / 16,384 /
20,480 / 24,576 / 30,720 / 40,960 kbps
 - d. Image Quality
 - i. Constant bit rate Motion priority / Normal / Quality priority
 - ii. Best effort Motion priority / Normal / Quality priority

- iii. VBR 10 steps
 - e. Transmission type Unicast, Multicast
 - 4. JPEG
 - a. Image quality 10 steps
 - b. Transmission type Pull, Push
- E. Audio
 - a. Audio Compression G.726 (ADPCM) 32kbps / 16kbps, G.711 64kbps, AAC-LC 64kbps / 96kbps / 128kbps
 - b. Audio Mode OFF / Mic input / Audio output / Interactive (Half duplex) / Interactive (Full duplex)
- F. OPERATION
 - 1. Super Dynamic On / Off
The level can be set in the range of 0 to 31.
 - 2. Intelligent Auto On / Off
 - 3. Adaptive Black Stretch The level can be set in the range of 0 to 255.
 - 4. Fog compensation On / Off (Only when Intelligent Auto is off.)
 - 5. Black light compensation
High light compensation BLC (Black light compensation) / HLC (High light compensation) / Off
(Only when Super dynamic and Intelligent Auto is off)
 - 6. Maximum shutter Off(1/30) to 1/10000
*1/30 Fix to 2/100 Fix is available during 30 fps mode only.*2/120 Fix is available during 60 fps mode only.
 - 7. Day & Night On / Off / Auto1 (Normal) / Auto2 (IR Light) / Auto3 (SCC)
 - 8. Digital Noise Reduction The level can be set in the range of 0 to 255.
 - 9. Video Motion Detection On / Off, 4 areas, Sensitivity:15 steps, Detection size:10 steps
 - 10. Privacy Zone On / Off, Up to 32 zones
 - 11. Camera Title (OSD) Up to 20 characters
 - 12. Zoom Ratio 40x
 - 13. Digital zoom 16x
 - 14. Panning Range 360-degrees endless
 - 15. Panning Speed
 - a. Manual Approx. 0.065°/s to 120°/s, Up to 256 steps (depending on the controller)
 - b. Preset Up to approx. 300°/s
 - 16. Tilting Range -15° to 195°
 - 17. Tilting Speed
 - a. Manual Approx. 0.065°/s to 120°/s, Up to 256 steps
 - b. Preset Up to approx. 300°/s
- G. NETWORK
 - 1. Network Interface 10Base-T / 100Base-TX, RJ-45 connector
 - 2. IP IPv6, IPv4
 - 3. Supported Protocols
 - a. IPv6 TCP/IP, UDP/IP, HTTP, HTTPS, RTP, FTP, SMTP, DNS, NTP, SNMP, DHCPv6, MLD, ICMP, ARP, DiffServ, IEEE 802.1x

- b. IPv4 TCP/IP, UDP/IP, HTTP, HTTPS, RTSP, RTP, RTP/RTCP, FTP, SMTP, DHCP, DNS, DDNS, NTP, SNMP, UPnP, IGMP, ICMP, ARP, DiffServ, IEEE 802.1x
 - 4. Max. User access Up to 14 users
 - 5. Mobile Terminal Compatibility iPad, iPhone, Android™ mobile terminals
- H. INTERFACE**
- 1. Monitor Output VBS : 1.0 V [p-p] / 75 ohm, NTSC / PAL composite
 - 2. Microphone input / Line input ø3.5 mm stereo mini jack (monaural input)
 - 3. Audio Output ø3.5 mm stereo mini jack (monaural output)
 - 4. External I/O Terminals ALARM IN 1 (DAY/NIGHT IN), ALARM IN 2 (ALARM OUT), ALARM IN 3 (AUX OUT)
 - 5. SD memory card slot 1 slot, SD/SDHC/SDXC
- I. ELECTRICAL**
- 1. Power Source AC24V, PoE+ (DC54V, Class 4), Tested PoE Injector(60W, DC54V)
 - 2. Power Consumption Approx. 55W (AC 24V), Approx. 25W (PoE+) Approx. 50W (Tested PoE injector)
- J. SAFTEY / EMC**
- 1. Safety UL (UL60950-1), C-UL (CAN/CSA C22.2 No.60950-1), EN60950-1
 - 2. EMC FCC (Part15 Class A), ICES003 Class A, EN55032 Class A,
- K. MECHANICAL**
- 1. Dimensions(D x H) ø229 mm x 392 mm (ø9-1/32 inches x 15-7/16 inches)
 - 2. Weight Approx. 5.0 kg (11.02 lbs)
 - 3. Construction material
 - a. Main body Aluminum die cast
 - b. Sunshields ABS+PC resin
 - c. Dome Polycarbonate resin
 - 4. Finish
 - a. Main body Natural silver
 - b. Sunshields Natural silver
 - c. Dome Clear
- L. ENVIRONMENTAL**
- 1. Ingress Resistance IP66, IEC60529 measuring standard compatible, Type 4X(UL50), NEMA 4X compliant
 - 2. Vandal Resistance Compliant with IEC 62262 IK10
 - 3. Operating Temperature -50 °C ~ +60 °C (-58 °F ~ 140 °F, AC24V)
-30 °C ~ +60 °C (-22 °F ~ 140 °F, PoE+)
 - 4. Operating Humidity 10 % ~ 100 % (without condensation)
- M. SOFTWARE OPTIONS**

1. WV-XAE100W Vehicle incident detection
2. WV-SAE100 Face Detection function
3. WV-SAE200 Intelligent video motion detection

Panasonic IP Cameras – Fixed Dome Camera

PART 1 GENERAL

The CCTV cameras installed at City of XXXX sites are to be manufactured by Panasonic. The system integrator providing the equipment will ensure that all units are in compliance with the general requirements listed in section 2.4 of this document.

1.01 SUMMARY

1.02 WARRANTY

- B. Provide manufacturer's standard warranty.

PART 2 PRODUCTS

2.3 MANUFACTURERS

- A. Panasonic System Networks Company
- B. Provide Video Surveillance Camera from single source manufacturer

2.4 PANASONIC WV-S2531LN FIXED DOME NETWORK CAMERA

A. GENERAL CHARACTERISTICS

1. The Fixed Dome Camera shall deliver H.265 stream and H.264 stream.
2. The Fixed Dome Camera shall produce a resolution of 1,920 x 1,080 pixels (Full HD 1080p) at up to 60 fps with a 16:9 aspect ratio.
3. The Fixed Dome Camera shall produce a resolution of 2,048 x 1,536 pixels at 30fps with a 4:3 aspect ratio.
4. The Fixed Dome Camera shall utilize an approximate 1/3 type high sensitivity MOS image sensor.
5. The Fixed Dome Camera shall feature a 144dB wide dynamic range based on Enhanced Super Dynamic and Adaptive Black Stretch technology (ABS).
6. The Fixed Dome Camera shall produce a color image with a minimum illumination of 0.012 lux and a monochrome image with 0.006 lux at F1.6, maximum shutter of 1/30s and High gain mode.
7. The Fixed Dome Camera shall offer a built-in IR illumination to produce a clear monochrome image in zero lux conditions with 40m (131feet) irradiation distance.

8. The Fixed Dome Camera shall be equipped a special coated cover for increasing the operational utility of outdoor cameras in rain weather.
9. The Fixed Dome Camera shall generate multiple simultaneous video streams of up to four (4) H.265 (Main profile) or H.264 (High profile) streams and JPEG streams.
10. The Fixed Dome Camera shall be equipped with intelligent auto mode, the technology for shooting license plate and person's face more clearly.
11. The Fixed Dome Camera shall be equipped with GOP control and Smart Facial coding which control an image quality of a stationary area, a moving area and a face, as bitrate reducing technology.
12. The Fixed Dome Camera shall produce encrypted stream.
13. The Fixed Dome Camera shall realize SSL / TLS communication with CA certificate.
14. A user shall be able to view video on a PC using a browser.
15. A user shall be able to view video on a smartphone and tablet using viewer software for iPhone and Android.
16. The Fixed Dome Camera shall offer Video Motion Detection (VMD) with four (4) programmable detection areas, 15 steps sensitivity level and 10 steps detection size.
17. The Fixed Dome Camera shall have Fog compensation function.
18. The Fixed Dome Camera shall have High light compensation (HLC) function.
19. The Fixed Dome Camera shall have Super Chroma Compensation (SCC) which realizes a better color reproducibility in the low illumination.
20. The Fixed Dome Camera shall provide up to eight (8) areas of electronic privacy masking.
21. The Fixed Dome Camera shall offer the prioritized stream control which transmits a video stream to a specified client PC or recorder preferentially.
22. The Fixed Dome Camera shall have a SD memory card slot that supports SD, SDHC and SDXC memory card for local storage.
23. The Fixed Dome Camera shall offer full-duplex bi-directional audio communication capability between the camera and monitoring site.
24. The Fixed Dome Camera shall have four (4) alarm sources of terminal input, VMD, command alarm and audio detection alarm that activate the processes such as SDXC/SDHC/SD memory recording, E-mail notification, HTTP alarm notification, Indication on browser, FTP image transfer and Panasonic alarm protocol output.

25. The Fixed Dome Camera shall conform to the ONVIF standard.

B. CAMERA

1. Image Sensor 1/3 type MOS image sensor
2. Scanning Mode Progressive
3. Minimum Illumination
 - a. Color 0.012 lux (F1.6, Maximum shutter: Max. 1/30s, Gain: On(High))
 - b. B/W 0.0 lux (with IR LED on)
0.006 lux (F1.6, Maximum shutter: Max. 1/30s, Gain: On(High))
4. Day & Night IR Cut filter Removal
5. Dynamic Range 144 dB typ. (Super Dynamic: On)
6. Built-in IR illumination
 - a. Irradiation distance Approx. 40m (131feet)

C. Lens

1. Vari-Focal Length 2.8 ~ 10mm (1/8 ~ 13/32 inches)
2. Max. Aperture Ratio 1 : 1.6 (WIDE) ~ 1 : 3.35 (TELE)
3. Angular Field of View
 - a. 16:9 aspect ratio H: 30° (TELE) - 108° (WIDE)
V: 17° (TELE) - 58° (WIDE)
 - b. 4:3 aspect ratio H: 25° (TELE) - 90° (WIDE)
V: 19° (TELE) - 65° (WIDE)
4. Focus adjustment Auto Back Focus (ABF) / Manual

D. VIDEO

1. Compression Format H.265, H.264, JPEG
2. Image Resolution
 - a. 16:9 aspect ratio (2 mega pixel mode)
1,920 x 1,080 / 1,280 x 720 / 640 x 360 / 320 x 180 (30/60fps)
 - b. 4:3 aspect ratio (3 mega pixel mode)
2,048 x 1,536 / 1,280 x 960 / 800 x 600 / 640 x 480 / 400 x 300 /
320 x 240 (30fps)
3. H.265 / H.264
 - a. Transmission Mode Constant bitrate, VBR, Frame rate priority, Best effort
 - b. Frame Rate 1 / 3 / 5 / 7.5 / 10 / 12 / 15 / 20 / 30 / 60 fps
 - c. Bit Rate/Client 64 / 128 / 256 / 384 / 512 / 768 / 1,024 / 1,536 / 2,048 / 3,072 /
4,096 / 6,144 / 8,192 / 10,240 / 12,288 / 14,336 / 16,384 /
20,480 / 24,576 / 30,720 / 40,960 kbps
 - d. Image Quality
 - i. Constant bit rate Motion priority / Normal / Quality priority
 - ii. Best effort Motion priority / Normal / Quality priority
 - iii. VBR 10 steps
 - e. Transmission type Unicast, Multicast
4. JPEG
 - a. Image quality 10 steps
 - b. Transmission type Pull, Push

E. Audio

- a. Audio Compression G.726 (ADPCM) 32kbps / 16kbps, G.711 64kbps, AAC-LC
- b. Audio Mode OFF / Mic input / Audio output / Interactive (Half duplex) / Interactive (Full duplex)

F. OPERATION

- 1. Super Dynamic On / Off
The level can be set in the range of 0 to 31.
- 2. Intelligent Auto On / Off
- 3. Adaptive Black Stretch The level can be set in the range of 0 to 255.
- 4. Fog compensation On / Off (Only when Intelligent Auto is off.)
- 5. Black light compensation High light compensation BLC (Black light compensation) / HLC (High light compensation) /
Off
(Only when Super dynamic and Intelligent Auto is off)
- 6. AGC The level can be set in the range of 0 to 11.
- 7. Maximum shutter Off(1/30) to 1/10000
*1/30 Fix to 2/100 Fix is available during 30 fps mode only.
- 8. Day & Night On / Off / Auto1 (Normal) / Auto2 (IR Light) / Auto3 (SCC)
- 9. Digital Noise Reduction The level can be set in the range of 0 to 255.
- 10. Video Motion Detection On / Off, 4 areas, Sensitivity:15 steps, Detection size:10 steps
- 11. Privacy Zone On / Off, Up to 8 zones
- 12. Camera Title (OSD) Up to 20 characters
- 13. Digital Zoom 3.6x

G. NETWORK

- 1. Network Interface 10Base-T / 100Base-TX, RJ-45 connector
- 2. IP IPv6, IPv4
- 3. Supported Protocols
 - a. IPv6 TCP/IP, UDP/IP, HTTP, HTTPS, RTP, FTP, SMTP, DNS, NTP, SNMP, DHCPv6, MLD, ICMP, ARP, DiffServ
 - b. IPv4 TCP/IP, UDP/IP, HTTP, HTTPS, RTSP, RTP, RTP/RTCP, FTP, SMTP, DHCP, DNS, DDNS, NTP, SNMP, UPnP, IGMP, ICMP, ARP, DiffServ
- 4. Max. User access Up to 14 users
- 5. Mobile Terminal Compatibility iPad, iPhone, Android™ mobile terminals

H. INTERFACE

- 1. Monitor Output VBS : 1.0 V [p-p] / 75 ohm, NTSC / PAL composite, Pin jack
- 2. Microphone input / Line input
ø3.5 mm stereo mini jack
- 3. Audio Output ø3.5 mm stereo mini jack (monaural output)
- 4. External I/O Terminals ALARM IN 1 (DAY/NIGHT IN), ALARM IN 2 (ALARM OUT), ALARM IN 3 (AUX OUT)
- 5. SD memory card slot 1 slot, SD/SDHC/SDXC

- I. ELECTRICAL**
1. Power Source DC 12V/750mA, PoE (DC48V, Class 0)
 2. Power Consumption Approx. 9W (DC 12V), Approx. 9.4W (PoE)
- J. SAFETY / EMC**
1. Safety UL (UL60950-1), C-UL (CAN/CSA C22.2 No.60950-1), CE, IEC60950-1
 2. EMC FCC (Part15 Class A), ICES003 Class A, EN55032 Class B, EN55024
- K. MECHANICAL**
1. Dimensions(D x H) \varnothing 164 mm x 139 mm (\varnothing 6-15/32 inches x 5-15/32 inches)
 2. Weight Approx. 1.6 kg (3.53 lbs, When using based bracket)
 3. Construction material
 - a. Main body Aluminum die cast
 - b. Front cover Clear polycarbonate resin
 4. Finish
 - a. Main body Light gray
 - b. Front cover Clear
- L. ENVIRONMENTAL**
1. Ingress Resistance IP66, IEC60529 measuring standard compatible, Type 4X(UL50), NEMA 4X compliant
 2. Vandal Resistance Compliant with IEC 62262 IK10
 3. Operating Temperature -40 °C ~ +50 °C (-40 °F ~ 122 °F, When IR-LED is on)
-40 °C ~ +60 °C (-40 °F ~ 140 °F, When IR-LED is off)
 4. Operating Humidity 10 % ~ 90 % (without condensation)

Panasonic IP Cameras – Panoramic Fixed Dome Camera

PART 1 GENERAL

The CCTV cameras installed at City of XXXX sites are to be manufactured by Panasonic. The system integrator providing the equipment will ensure that all units are in compliance with the general requirements listed in section 2.4 of this document.

1.01 SUMMARY

1.02 WARRANTY

- C. Provide manufacturer's standard warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Panasonic System Networks Company
- B. Provide Video Surveillance Camera from single source manufacturer

2.2 PANASONIC WV-SFV481 9MP 360-DEGREE OUTDOOR READY NETWORK CAMERA

A. GENERAL CHARACTERISTICS

1. The 360-degree Camera shall produce a resolution of 2,992 x 2,992 pixels at up to 15 fps with a 9MP fisheye mode.
2. The 360-degree Camera shall produce a resolution of 2,048 x 2,048 pixels at up to 30 fps with a 4MP fisheye mode.
3. The 360-degree Camera shall utilize an approximate 1/2-inch high sensitivity MOS image sensor.
4. The 360-degree Camera shall offer Wide Dynamic Range (WDR).
5. The 360-degree Camera shall produce a color image with a minimum illumination of 0.02 lux and a monochrome image with 0.01 lux at F1.9, shutter speed of 16/30s and High gain mode.
6. The 360-degree Camera shall generate multiple simultaneous video streams of JPEG and H.264 high profile.
7. The 360-degree Camera shall be equipped with GOP control and Auto-VIQS as bitrate reducing technology.

8. The 360-degree Camera shall utilize 3D-Digital Noise Reduction (3D-DNR) to remove visual noises in low light conditions.
9. The 360-degree Camera shall offer Video Motion Detection (VMD) with four (4) programmable detection areas, 15 steps sensitivity level and 10 steps detection size.
10. The 360-degree Camera shall offer an optional intelligent VMD (i-VMD) which provides intruder detection, loitering detection, scene change detection, object detection and cross line detection.
11. The 360-degree Camera shall offer an optional business intelligent functionality which provides heat map, people counting and Moving Object Remover (MOR).
12. The 360-degree Camera shall provide Variable Image Quality on Specified area (VIQS) which sets different image qualities to up to eight (8) areas in the full view to reduce bandwidth and storage capacity requirements.
13. The 360-degree Camera shall have Lens Distortion Compensation to compensate the barrel distortion.
14. The 360-degree Camera shall provide up to eight (8) areas of electronic privacy masking.
15. The 360-degree Camera shall offer the prioritized stream control which transmits a video stream to the specified client PC or recorder preferentially.
16. The 360-degree Camera shall have a SD memory card slot that supports SD, SDHC and SDXC memory card for local storage.
17. The 360-degree Camera shall offer full-duplex bi-directional audio communication between the camera and monitoring site.
18. The 360-degree Camera shall conform to the ONVIF standard.

B. CAMERA

- | | |
|-------------------------|---|
| 1. Image Sensor | 1/2 type MOS image sensor |
| 2. Effective Pixels | Approx. 12.4 megapixels |
| 3. Scanning Mode | Progressive |
| 4. Scanning Area | 5.54 mm (H) x 5.54 mm (V) {7/32 inches(H) x 7/32 inches(V)} |
| 5. Minimum Illumination | |
| a. Color | 0.3 lux (F1.9, Shutter speed of 1/30s, Gain: On(High)) |
| b. B/W | 0.2 lux (F1.9, Shutter speed of 1/30s, Gain : On(High)) |

C. Lens

- | | |
|--------------------------|----------------------------------|
| 1. Focal Length | 1.342mm |
| 2. Angular Field of View | Horizontal: 180°, Vertical: 180° |
| 3. Focus adjustment | Auto Back Focus, Manual |

D. VIDEO

1. Compression Format H.264, JPEG
2. Distribution mode 9M Fisheye mode, 4M fisheye mode, Double Panorama mode,
Quad PTZ / Single PTZ mode, 8M fisheye + Double Panorama mode, 4M fisheye + Double panorama mode, 8M fisheye + Quad PTZ mode, 4M fisheye + Quad PTZ mode, Quad streams mode,
Panorama mode, 8M fisheye + Panorama mode, 4M fisheye + Panorama mode
3. H.264
 - a. Transmission Mode Constant bitrate / VBR / Frame rate priority / Best effort / Advanced VBR
 - b. Frame Rate distribution 1 / 3 / 5 / 7.5 / 10 / 12 / 15 / 20 / 30 fps (depending on mode.)
 - c. Bit Rate/Client 64 / 128 / 256 / 384 / 512 / 768 / 1,024 / 1,536 / 2,048 / 3,072 / 4,096 / 6,144 / 8,192 / 10,240 / 12,288 / 14,336 / 16,384 / 20,480 / 24,576 / 30,720 kbps (depending on distribution mode.)
 - d. Transmission type Unicast, Multicast
4. JPEG
 - a. Image quality 10 steps
 - b. Transmission type Pull, Push

E. Audio

- a. Audio Compression G.726 (ADPCM) 32kbps / 16kbps, G.711 64kbps, AAC-LC
- b. Audio Mode Off / Microphone input / Audio output / Interactive (Half duplex) / Interactive (Full duplex)

F. OPERATION

1. Wide Dynamic Range On / Off
2. Adaptive Black Stretch On / Off
3. AGC On (LOW, MID, HIGH) / Off
4. Day & Night On/ Off
5. Digital Noise Reduction High / Low
6. Video Motion Detection 4 areas, Sensitivity:15 steps, Detection size:10 steps
7. Privacy Zone On/Off, up to 8 zones
8. VIQS Up to 8 zones (fisheye mode only)
9. Camera Title (OSD) Up to 20 characters

G. NETWORK

1. Network Interface 10Base-T / 100Base-TX, RJ-45 connector
2. IP IPv6, IPv4
3. Supported Protocols
 - a. IPv6 TCP/IP, UDP/IP, HTTP, HTTPS, RTP, FTP, SMTP, DNS, NTP, SNMP, DHCPv6, MLD, ICMP, ARP
 - b. IPv4 TCP/IP, UDP/IP, HTTP, HTTPS, RTSP, RTP, RTP/RTCP, FTP,

- | | | |
|----|------------------|--|
| 4. | Max. User access | SMTP, DHCP, DNS, DDNS, NTP, SNMP, UPnP, IGMP, ICMP, ARP
Up to 14 users |
| 5. | GUI Language | English, Italian, French, German, Spanish, Portuguese, Russian,
Chinese, Japanese |

H. Intelligent function (optional)

- | | | |
|----|-----------------------|--|
| 1. | Intelligent VMD | Intruder detection, Object detection, Cross line detection,
Loitering detection, Scene change detection |
| 2. | Business intelligence | Heat map, People count, Moving Object Remover (MOR) |

I. INTERFACE

- | | | |
|----|------------------------|---|
| 1. | Monitor Output | VBS : 1.0 V [p-p] / 75 ohm, NTSC / PAL composite,
ø3.5mm mini jack, for adjustment |
| 2. | Microphone | Built-in microphone |
| 3. | Audio Output | ø3.5 mm stereo mini jack |
| 4. | External I/O Terminals | ALARM IN 1, ALARM IN 2/ALARM OUT,
ALARM IN 3/AUX OUT |
| 5. | SD memory card slot | 1 slot, SD/SDHC/SDXC |

J. ELECTRICAL

- | | | |
|----|-------------------|--|
| 1. | Power Source | DC 12V, PoE |
| 2. | Power Consumption | Approx. 10.9W (DC 12V), Approx. 9.6W (PoE) |

K. SAFETY / EMC

- | | | |
|----|--------|--|
| 1. | Safety | UL (UL60950-1), C-UL (CAN/CSA C22.2 No.60950-1),
CE, IEC60950-1 |
| 2. | EMC | FCC (Part15 Class A), ICES003 Class A, EN55022 Class B,
EN55024 |

L. MECHANICAL

- | | | |
|----|-----------------------|--|
| 1. | Dimensions (D x H) | ø150 mm x 52.1 mm {ø5-19/32 x 2-3/64 inches}
(excluding the base bracket) |
| 2. | Weight | Approx. 0.4 kg (0.88 lbs.) |
| 3. | Construction material | ABS resin |
| 4. | Finish | Sail white |

M. ENVIRONMENTAL

- | | | |
|----|-------------------------------------|------------------------------------|
| 1. | Operating Temperature | |
| a. | Ceiling, Wall, Camera mount bracket | -10 °C ~ +50 °C (14 °F ~ 122 °F) |
| b. | Desktop, Tripod | -10 °C ~ +40 °C (14 °F ~ 104 °F) |
| 2. | Operating Humidity | 10 % ~ 90 % (without condensation) |

N. SOFTWARE OPTIONS

- | | | |
|----|---|--|
| 1. | Extension Software for intelligent function | |
|----|---|--|

END OF SECTION

28 30 00 Security Detection, Alarm and Monitoring

1.0 General

The Security Detection and Alarm Monitoring systems installed at City of XXXX sites are to be manufactured by DSc by Tyco. The system integrator providing the equipment will ensure that all units are in compliance with the general requirements listed in section 2.5 of this document.

2.0 Introduction

The purpose of this section is to introduce you to the PC1864 alarm panel and to provide you with detailed information on its specifications and features. The following areas are covered in this section:

- Regulatory requirements
- Model features

3.0 Regulatory Requirements - Canada

ULC

- i. ULC-S545-2002 Standard for Residential Fire Warning System Control Units
- ii. ORD-C1023-1974 Standard for Household Burglar Alarm System Units
- iii. CAN/ULC-S304-2006 Standard for Central & Monitoring Station Burglar Alarm Systems
- iv. CAN/ULC-S559-2004 Standard for Equipment for Fire Signal Receiving Centers and Systems

IC

- v. ICES-003 (CISPR22 Class B) Standard for Interference Causing Equipment, Digital Apparatus
- vi. IC-CS03 Issue 9, Industry Canada Terminal Equipment Technical Specifications

4.0 Technical Requirements

- 3.1 8 on-board zones
- 3.2 Expandable to 64 hardwired zones
- 3.3 Expandable to 64 wireless zones
- 3.4 4 PGM outputs: expandable to 14 (PC5204, PC5208)
- 3.5 Support for template programming
- 3.6 Connect up to 8 supervised keypads
- 3.7 Support for up to 8 partitions
- 3.8 Supports up to 500-event buffer
- 3.9 Supports up to 95 user codes
- 3.10 ANSI/SIA CP-01 compliant
- 3.11 Supports wire free keypads with TR5164-433 transceiver
- 3.12 Compatible with leading edge interactive services supported by DSC

END OF SECTION

28 50 00 Specialized Systems – Intercom Entry Systems

The Intercom Entry Systems installed at City of XXXX sites are to be manufactured by Commend International. The system integrator providing the equipment will ensure that all units are in compliance with the general requirements listed in section 2.6 of this document.

1.0 Technical Specifications – ES831/3A

- .1 Fully interoperable with Commend GE 800 / GE300 Intercom Servers
- .2 Keyboard supports ability to connect 12 buttons, with plug for row/column matrix
- .3 Omnidirectional electret microphone for max. 7 m (23 ft) speaking distance
- .4 Loudspeaker utilizes special membrane type for optimal sound quality, sound pressure: 85 dB/1 W/1 m (3.28 ft), 8 Ohm
- .5 Built-in amplifier 2.5 W output power with built-in loudspeaker: 1.5 W
- .6 1 input for floating contacts, max. 1 KOhm (detection of 5 input states)
- .7 1 relay output 30V/1A
- .8 Call indication: multifunctional LED (colours: red, green, blue)
- .9 Frequency range: 200 — 16,000 Hz
- .10 Operating temperature range: -20° C to +70° C (-4° F to 158° F)
- .11 Storage temperature range: -20° C to +70° C (-4° F to 158° F)
- .12 Relative humidity: up to 95 %
- .13 Expansion: pluggable screw terminals - expansion plug for e.g. EB 2E2A
- .14 Cabling: star feed, 2-wire, twisted
- .15 Power Supply: From Intercom Server or optional external power supply enabling greater line length - (12-24 VAC or 15-35 VDC, 500 mA)
- .16 Signaling: 2B + D (2 x 64 kBit/s speech, 16 kBit/s data)
- .17 Dimensions: 875 x 109 x 40 mm (3.45 x 4.29 x 1.58 in)
- .18 Vandal Resistant (EN 62262 IK09) Housing with stainless steel face plate

2.0 Technical Specifications – EF 962H

- .1 IP rating: IP54 (acc. EN 60529)
- .2 Mechanical impact resistance: IK09 (acc. EN 62262)
- .3 Front Panel: stainless steel, 3 mm (0.12 in)
- .4 Microphone: electret condenser microphones polar pattern: omnidirectional
- .5 Loudspeaker: special membrane type for optimal sound quality, 8 ohm
- .6 Sound pressure Level: 85 dB/1 W/1 m (3.28 ft)
- .7 Amplifier:) integrated class-D amplifier with 10 W
- .8 Inputs: 2 inputs for floating contacts (IP: detection of 5 input states)
- .9 Outputs: 2 relay outputs (1 switch-over contact, 1 normally open contact) max. 60 VDC, 2 A, 60 W, expected life: min. 5×10^6 (2 A), 10^7 (1 A)
- .10 Call button: EF 62H: stainless steel button EF 962HM: red mushroom button.
- .11 IP transmission bandwidth: 16 KHz
- .12 SIP Transmission bandwidth: 7 KHz
- .13 Operating Temperature Range: -30 °C to 70 °C (-22 °F to 158 °F)
- .14 Storage Temperature Range: -30 °C to 70 °C (-22 °F to 158 °F)
- .15 Relative Humidity: up to 95%, not condensing
- .16 Connections: pluggable spring clamp terminals, expansion plug e.g. for EB2E2AHE, IP Uplink: shielded RJ45 modular jack
- .17 Power Supply: PoE (Power over Ethernet): IEEE 802.3af power consumption: Class 0 (0.44 to 12.96 W)
- .18 Cabling: minimum Cat5. The maximum line length of Cat. 5 cabling in a LAN is 90 m (295 ft) - e.g. from switch to Intercom station.
- .19 IP Protocols: IPv4, UDP, DHCP, RTP, RTCP, SNMPv2c, SNTPv4

- .20 SIP Protocols; SIP (RFC 3261), SNMPv2, STUN, TFTP, URI (RFC 2396), DTMF Decoding (RFC 2876, RFC 2833), SIP User Agent (UDP RFC 3261), SIP Refer Method (RFC 3515)
- .21 Audio Codecs: G.711 a-Law, G.711 p-Law, G.722
- .22 Data rate: 10/100 MBit/s (Full/Half Duplex) Auto MDIX
- .23 Mounting: Flush or Surface mount with accessory boxes
- .24 Dimensions: front panel (W x H): 110 x 151 mm (4.33 x 5.95 in) depth flush mount: 48 mm (1.89 in) depth surface mount: 84 mm (3.3 in), except for EF 62W: 55 mm (2.2 in)
- .25 Communication Ports: SIP – UDP 5060, RTP – UDP 16384 incoming, UDP 16400 (configurable), TCP 16399 station config (not configurable)
- .26 Compatible Third Party SIP Servers: Cisco, Digium, Avaya/Nortel, Innovaphone, Alcatel, Siemens, 3CX, Starface, Astra/Ericsson, Kamailio, FreeSwitch, ELMPEG, 2N, AVM, SipGate, Vodafone Arcor, blue SIP, Mitel

3.0 Technical Specifications – GE 300 Server

- .1 Intercom Server with five plug-in slots
- .2 Up to 40 subscribers possible
- .3 One AF input (for music or alarm)
- .4 Two inputs for floating contacts
- .5 Two relay outputs: max switching capacity 60W / 62.5 VA, max switching current 2A, max switching voltage 60 VDC/30VAC
- .6 Configuration via Ethernet (Layer 2) or RS-232
- .7 Power Supply: 24 VDC
- .8 Emergency Power Consumption: without cards, 200 mA, maximum 40 VA
- .9 Power Consumption: max 30W, 60W, or 70W depending on settings
- .10 Frequency Response: 50 Hz to 150 kHz (-3dB)

- .11 Total Harmonic Distortion: <0.9%
- .12 Music Input: max 800 mV RMS at 10 k Ω , 16 kHz
- .13 Inputs – IN1, IN2: for floating contacts, max. line resistance = 1.5 k Ω
- .14 Operating temperature range: 0° C to +50° C (32° F to 122° F)
- .15 Storage temperature range: -30° C to +60° C (-22° F to 140° F)
- .16 Relative Humidity: 20 to 80%, not condensing
- .17 Mounting: wall mounting
- .18 Dimensions: 310x210x77.5 mm
- .19 Max Subscribers: 16 – 30W PS, 20 – 60W PS

4.0 Technical Specifications – GE 800 Server

- .1 Compatibility: IP, 2-wire, and 4 wire subscriber stations
- .2 Expandability: up to 25,000 subscriber stations without restrictions, 112 per housing up to 239 housings
- .3 Power Supply: 24VAC 80VA, 24-35VDC, 80W
- .4 Emergency power consumption: 200 mAh, plus load from configured cards
- .5 Frequency range: 50Hz to 16 kHz
- .6 Operating temperature range: 0° C to +50° C (32° F to 122° F)
- .7 Storage temperature range: -30° C to +60° C (-22° F to 140° F)
- .8 Dimensions: 483 x 133 x229 mm
- .9 Relative Humidity: 20 to 80%, not condensing
- .10 Mounting: 19 inch rack mount, 3U

- .11 **Relay outputs:** max switching capacity 60W / 125 VA, max switching current 2A, max switching voltage 60 VDC/40VAC
- .12 Music Input: max 800 mV RMS at 10 k Ω , 16 kHz
- .13 Inputs – IN1, IN2: for floating contacts, max. line resistance = 1.5 k Ω
- .14 Thermal dissipation loss: 45.2W

END OF SECTION

26 33 00 Battery Equipment

1.0 General

The battery backup units installed at City of XXXX sites are to be manufactured by APC by Schneider Electric. The system integrator providing the equipment will ensure that all units are in compliance with the general requirements listed in section 2.9 of this document.

2.0 Regulatory Compliance

UL 1449, UL 1778CSA, CSA C22.2 No 107.1, FCC part 15 Class, ICES-003

3.0 Technical Requirements – 1.5kVA Standalone UPS

- .1 Battery power: 1500VA / 750W
- .2 Total Controlled outlets = 4
- .3 LCD display
- .4 Remote reboot capability via single switched outlet
- .5 User replaceable batteries
- .6 Max output power capacity: 1.0 kWatts
- .7 Nominal output voltage: 120VAC
- .8 Output voltage distortion: less than 5%
- .9 Secondary output voltages: 110, 127
- .10 Topology: Line interactive
- .11 Waveform type: Sine wave
- .12 Transfer time: max 10 ms

- 4.0 Technical Requirements – 1.5 kVA Rack Mount UPS
 - 1.0 Battery power: 1500VA / 750W
 - 2.0 Total Controlled outlets = 3
 - 3.0 LCD display
 - 4.0 Remote reboot capability via single switched outlet
 - 5.0 Network management capable via SmartSlot and APC PowerChute Network Monitoring Software
 - 6.0 User replaceable batteries
 - 7.0 Nominal output voltage: 120VAC
 - 8.0 Output voltage distortion: less than 5%
 - 9.0 Secondary output voltages: 110, 127
 - 10.0 Topology: Line interactive
 - 11.0 Waveform type: Sine wave
 - 12.0 Transfer time: max 10 ms
 - 13.0 Output frequency (sync to mains): 50/60Hz +/- 3 Hz

END OF SECTION

27 11 00 Communications Equipment Room Fittings

1.0 General

The communications room fittings installed at City of XXXX sites are to be manufactured by Middle Atlantic. The system integrator providing the equipment will ensure that all units are in compliance with the general requirements listed in section 2.10 of this document.

2.0 Technical Specification – Full Height Rack

- 2.1 Standards Compliance: c/UL 2416, ASCE 7-10, RoHS, Greenguard, CSA
- 2.2 Overall dimensions of rack shall be: W x D = 1800 x 702 mm
- 2.3 Useable dimensions of rack shall be: W x D – 1648 x 654 mm
- 2.4 Usable interior width: 483 mm / 19 inches
- 2.5 Four post construction with e extra wide pairs of 11 gauge 10-32 threaded rack rail with numbered rack space increments.
- 2.6 c/UL listed load capacity: 2500 lbs.
- 2.7 Static load capacity: 10,000 lbs.
- 2.8 Seismic certified load capacity: 900 lbs., requires WRK-Z4 option
- 2.9 ½ inch, 2/3 inch, 1 inch, 1 ½ inch electrical knockouts on split rear plates top and bottom for cable pass through
- 2.10 Key locked solid rear door included
- 2.11 Black powder coat finish
- 2.12 Required accessories: vented side panels, vented locking doors, roof fan panel kits with high flow i.e. 550 CFM fan kits, rack shelves, horizontal and vertical cable management, horizontal and vertical power distribution units

3.0 Technical Specification – Wall Mount Rack (10U)

- 3.1 Standards Compliance: UL Listing No: E313734, ASCE 7-10, RoHS, Greenguard, CSA
- 3.2 Overall dimensions of 10U rack shall be: H x D – 624 x 594 mm
- 3.3 Useable dimensions of 10U rack shall be: H x D - 444.5 x 508 mm
- 3.4 Useable interior width: 483 mm / 19 inches
- 3.5 Two 11 gauge 10-32 threaded rack rail with numbered rack space increments.
- 3.6 c/UL listed load capacity: 200 lbs.
- 3.7 Static load capacity: 800 lbs.
- 3.8 Seismic certified load capacity: 155 lbs. 2007 & 2010 CBC; 2006, 2009 & 2012 IBC; ASCE 7-05 (2005 Edition) & ASCE 7-10 (2010 Edition) and the 2006 & 2009 editions of NFPA 5000 for use in areas of high seismicity,
- 3.9 ½ inch, 2/3 inch, 1 inch, 1 ½ inch, 2 inch and 3 inch electrical knockouts on split rear plates top and bottom for cable pass through
- 3.10 Locking solid front door
- 3.11 Black powder coat finish
- 3.12 Required accessories: vented side panels, vented locking doors, roof fan panel kits with high flow i.e. 550 CFM fan kits, rack shelves, horizontal and vertical cable management, horizontal and vertical power distribution units

4.0 Technical Specification – Wall Mount Rack (16U)

- 4.1 Standards Compliance: UL Listing No: E313734, ASCE 7-10, RoHS, Greenguard, CSA
- 4.2 Overall dimensions of 16U rack shall be: H x D – 891 x 566 mm
- 4.3 Useable dimensions of 16U rack shall be: H x D - 711 x 508 mm
- 4.4 Useable interior width: 483 mm / 19 inches
- 4.5 Two 11 gauge 10-32 threaded rack rail with numbered rack space increments.
- 4.6 c/UL listed load capacity: 200 lbs.
- 4.7 Static load capacity: 800 lbs.

- 4.8 Seismic certified load capacity: 155 lbs. 2007 & 2010 CBC; 2006, 2009 & 2012 IBC; ASCE 7-05 (2005 Edition) & ASCE 7-10 (2010 Edition) and the 2006 & 2009 editions of NFPA 5000 for use in areas of high seismicity,
- 4.9 ½ inch, 2/3 inch, 1 inch, 1 ½ inch, 2 inch and 3 inch electrical knockouts on split rear plates top and bottom for cable pass through
- 4.10 Locking solid front door
- 4.11 Black powder coat finish
- 4.12 Required accessories: vented side panels, vented locking doors, roof fan panel kits with high flow i.e. 550 CFM fan kits, rack shelves, horizontal and vertical cable management, horizontal and vertical power distribution units
- 5.0 **Technical Specification – Wall Mount Rack (22U)**
- 5.1 Standards Compliance: UL Listing No: E313734, ASCE 7-10, RoHS, Greenguard, CSA
- 5.2 Overall dimensions of 22U rack shall be: H x D – 1246 x 566 mm
- 5.3 Useable dimensions of 22U rack shall be: H x D – 1067 x 508 mm
- 5.4 Useable interior width: 483 mm / 19 inches
- 5.5 Two 11 gauge 10-32 threaded rack rail with numbered rack space increments.
- 5.6 c/UL listed load capacity: 300 lbs.
- 5.7 Static load capacity: 1,200 lbs.
- 5.8 Seismic certified load capacity: 155 lbs. 2007 & 2010 CBC; 2006, 2009 & 2012 IBC; ASCE 7-05 (2005 Edition) & ASCE 7-10 (2010 Edition) and the 2006 & 2009 editions of NFPA 5000 for use in areas of high seismicity,
- 5.9 ½ inch, 2/3 inch, 1 inch, 1 ½ inch, 2 inch and 3 inch electrical knockouts on split rear plates top and bottom for cable pass through
- 5.10 Locking front door with plexiglass insert
- 5.11 Black powder coat finish
- 5.12 Required accessories: vented side panels, vented locking doors, roof fan panel kits with high flow i.e. 550 CFM fan kits, rack shelves, horizontal and vertical cable management, horizontal and vertical power distribution units

END OF SECTION

27 20 00 Data Communications

1.0 General

The data communications equipment installed at City of Brampton sites are to be manufactured by Cisco Systems. The system integrator providing the equipment will ensure that all units are in compliance with the general requirements listed in section 2.7 of this document.

2.0 Regulatory Compliance

The products specified herein comply with UL (UL 60950), CSA (CSA 22.2), CE mark, FCC Part 15 (CFR 47) Class A.

3.0 Technical Specifications – 10 Port PoE Switch, SG250-10P

- .1 Device Type: Switch, Gigabit, 10 Ports, PoE
- .2 Enclosure Type; Compact, single unit
- .3 Ports: 8 x 10/100/1000, 2 x Gigabit SFP/RJ-45
- .4 Power Over Ethernet Capability: PoE+ (8 ports, 62W)
- .5 Switching Capacity: 20-Gbps
- .6 Forwarding performance (64-byte packets): 14.88-Mpps forwarding performance (64-byte packet size)
- .7 MAC address table size: 8K entries
- .8 Capacity (active VLANs): 256
- .9 Remote management protocol: SNMP, RMON, HTTP, HTTPS, TFTP, Telnet, SSH
- .10 Features: Layer 2 switching, Layer 3 switching, DHCP support, BOOTP support, VLAN support, IGMP snooping, Syslog support, port mirroring, DiffServ support, Weighted Round Robin (WRR) queuing, Broadcast Storm Control, IPv6 support, Multicast Storm Control, Unicast Storm Control, SNTP support, Spanning Tree Protocol (STP) support, Rapid Spanning Tree Protocol (RSTP), Multiple Spanning Tree (MSTP), Trivial File Transfer Protocol (TFTP) support, access control list (ACL) support, quality of service (QoS), jumbo frames support, MLD snooping, SNMP, RMON, SNTP, Cisco Discovery Protocol, Auto SmartPorts

- .11 Compliant standards: IEEE 802.3, IEEE 802.3u, IEEE 802.3z, IEEE 802.1D, IEEE 802.1Q, IEEE 802.3ab, IEEE 802.1p, IEEE 802.3x, IEEE 802.3ad (LACP), IEEE 802.1w, IEEE 802.1x, IEEE 802.1s, IEEE 802.3af PoE, IEEE 802.3at PoE, IEEE 802.3az
- .12 RAM: 512 MB
- .13 Flash Memory: 256 MB Flash
- .14 Status Indicators: System, link/speed per port
- .15 Expansion and Connectivity Interfaces: 8 x 10BASE-T/100BASE-TX/1000BASE-T, RJ-45 (PoE+), 2 x Gigabit SFP/RJ-45 (60W PoE PD)
- .16 Power Supply: Power supply, external
- .17 Voltage Required: AC 120/230V (50/60 Hz)
- .18 Width: 11.0 in (280 mm)
- .19 Depth: 6.69 in (170 mm)
- .20 Height: 1.45 in (44 mm)
- .21 Weight: 2.65 lb (1.2 kg)
- .22 Warranty: Limited Lifetime Warranty
- .23 Operating temperature range: 0° C to +50° C (32° F to 122° F)
- .24 Storage temperature range: -20° C to +70° C (-4° F to 158° F)
- .25 Relative Humidity (operations and storage): 10 to 90%, not condensing

4.0 Technical Specifications – 24 Port PoE Switch @ 195W, SC250X-24P

- .1 Device Type: Switch, Gigabit, 24 Ports, PoE/PoE+
- .2 Enclosure Type: Rack mount, 1U
- .3 Ports: 24 x 10/100/1000, 2 x 10 GE copper, 2 x 10 GE SFP+
- .4 Power Over Ethernet Capability: PoE+ (24 ports, 195W)
- .5 Switching Capacity: 128-Gbps

- .6 Forwarding performance (64-byte packets): 95.23-Mpps forwarding performance (64-byte packet size)
- .7 MAC address table size: 8K entries
- .8 Capacity (active VLANs): 256
- .9 Remote management protocol: SNMP, RMON, HTTP, HTTPS, TFTP, Telnet, SSH
- .10 Features: Layer 2 switching, Layer 3 switching, DHCP support, BOOTP support, VLAN support, IGMP snooping, Syslog support, port mirroring, DiffServ support, Weighted Round Robin (WRR) queuing, Broadcast Storm Control, IPv6 support, Multicast Storm Control, Unicast Storm Control, STNP support, Spanning Tree Protocol (STP) support, Rapid Spanning Tree Protocol (RSTP), Multiple Spanning Tree (MSTP), Trivial File Transfer Protocol (TFTP) support, access control list (ACL) support, quality of service (QoS), jumbo frames support, MLD snooping, SNMP, RMON, STNP, Cisco Discovery Protocol, Auto SmartPorts
- .11 Compliant standards: IEEE 802.3, IEEE 802.3u, IEEE 802.3z, IEEE 802.1D, IEEE 802.1Q, IEEE 802.3ab, IEEE 802.1p, IEEE 802.3x, IEEE 802.3ad (LACP), IEEE 802.1w, IEEE 802.1x, IEEE 802.1s, IEEE 802.3af PoE, IEEE 802.3at PoE, IEEE 802.3az
- .12 RAM: 512 MB
- .13 Flash Memory: 256 MB Flash
- .14 Status Indicators: System, link/speed per port
- .15 Expansion and Connectivity Interfaces: 24 x 10BASE-T/100BASE-TX/1000BASE-T, RJ-45, PoE, 2 x 10GBASE-T, 2 x SFP+
- .16 Power Supply: Internal
- .17 Voltage Required: AC 120/230V (50/60 Hz)
- .18 Width: 17.3 in (440 mm)
- .19 Depth: 10.12 in (257 mm)
- .20 Height: 1.45 in (44 mm)
- .21 Weight: 8.51 lb (3.86 kg)
- .22 Warranty: Limited Lifetime Warranty
- .23 Operating temperature range: 0° C to +50° C (32° F to 122° F)
- .24 Storage temperature range: -20° C to +70° C (-4° F to 158° F)

.25 Relative Humidity (operations and storage) : 10 to 90%, not condensing

5.0 Technical Specifications – 24 Port PoE Switch @ 375W, SC350X-24MP

- .1 Device Type: Switch: L3 managed, 24 x 10/100/1000 + 2 x 10GE combo + 2 x 10GE SFP+, rack-mountable, Max PoE
- .2 Enclosure Type: Rack mount, 1U
- .3 Ports: 24 x 10/100/1000 + 2 x 10GE copper/SFP+ combo + 2 x 10GE SFP+
- .4 Power Over Ethernet Capability: PoE, PoE+ and 60W PoE (375W)
- .5 Switching Capacity: 128-Gbps
- .6 Forwarding performance (64-byte packets): 95.23-Mpps forwarding performance (64-byte packet size)
- .7 MAC address table size: 16K entries
- .8 Capacity (active VLANs): 4000
- .9 Remote management protocol: SNMP1, RMON1, RMON2, RMON3, RMON9, Telnet, SNMPv3, SNMPv2c, HTTP, HTTPS, SSH, CLI
- .10 Routing: Static IPv4 /IPv6 routing
- .11 Features: Stacking, flow control, Layer 2 switching, Layer 3 switching, VLAN support, IPv6 support, Spanning Tree Protocol (STP) support, Rapid Spanning Tree Protocol (RSTP) support, Multiple Spanning Tree Protocol (MSTP) support, access control list (ACL) support, quality of service (QoS), reset button, LACP support, Energy Efficient Ethernet, dynamic VLAN support (GVRP), advanced threat protection, IPv6 first-hop security, static routing, sFlow, RSPAN
- .12 Compliant standards: IEEE 802.3, IEEE 802.3u, IEEE 802.3z, IEEE 802.1D, IEEE 802.1Q, IEEE 802.3ab, IEEE 802.3ae, IEEE 802.3an, IEEE 802.1p, IEEE 802.3x, IEEE 802.3ad (LACP), IEEE 802.1w, IEEE 802.1x, IEEE 802.1s, IEEE 802.3af, IEEE 802.3at, IEEE 802.3az
- .12 RAM: 512 MB
- .13 Flash Memory: 256 MB Flash
- .14 Status Indicators: System, Master, Fan, Stack ID, Link/Speed per port

- .15 Expansion and Connectivity Interfaces: 24 x 10Base-T/100Base-TX/1000Base-T - RJ-45 - PoE, 2 x 10GBase-T/SFP+ combo, 2 x SFP+, 1 x console - RJ45
- .16 Power Supply: Internal
- .17 Voltage Required: AC 120/230V (50/60 Hz)
- .18 Width: 17.3 in (440 mm)
- .19 Depth: 13.8 in. (350 mm)
- .20 Height: 1.73 in. (44 mm)
- .21 Weight: 12.54 lb (5.69 kg)
- .22 Warranty: Enhanced limited Lifetime Warranty
- .23 Operating temperature range: 0° C to +50° C (32° F to 122° F)
- .24 Storage temperature range: -20° C to +70° C (-4° F to 158° F)
- .25 Relative Humidity (operations and storage) : 10 to 90%, not condensing

END OF SECTION

27 22 00 Data Communications Hardware

1.0 General

The computers, laptops, workstations, servers, and storage arrays installed at City of XXXX sites are to be manufactured by either Dell or Hewlett Packard.. The system integrator providing the equipment will ensure that all units are in compliance with the general requirements listed in section 2.7 of this document.

2.0 Regulatory Compliance

It is the responsibility to the integrator to ensure that all supplied hardware have the required UL, c/UL, CSA and IC certifications where required.

3.0 Technical Requirements







Due to the rapid pace of change of computer technology, formal specifications for each class of device have not been provided. It is the responsibility of the integrator to confirm the compatibility of each laptop, computer, workstation, server, and storage array against manufacturer provider minimum configurations for system performance. Should any deficiencies in system operation due to incorrect or incompatible system configurations be found, it will be the responsibility of the solution provider to correct the deficiencies at their sole expense.

Addendum 1, Door Locks, and Keys

1. All locking door hardware must be Medeco M3, Large Form Factor Interchangeable Core (M3, LFIC). Any hardware that is not M3, LFIC compliant will be upgraded to this standard as part of any project including:
 - a. Retrofits
 - b. New construction
 - c. State of good repair
 - d. Renovation
2. Security Services is not responsible for the specification of mechanical hardware outside of:
 - a. LFIC Core, Cylinder
 - b. M3 keys (on CoB keyway)
3. All doors being re-keyed will have the new key hierarchy designed by City of Brampton Security Services using the City of Brampton M3 keyway in collaboration with the user group.
4. All keys will be numbered according to the City of Brampton Security Services supplied key hierarchy, and packaged in accordance with [Appendix A](#)
5. All keys will be delivered to City of Brampton Security Services and Security Services will distribute the keys to the user group(s)
6. The hardware supplier is not to maintain any inventory of keys after the project, and all miss-cut keys that are not able to be returned the manufacturer for warranty are to be given to Security Services
7. **NO NEW City of Brampton Key is to be issued to an outside vendor without City of Brampton Security Services approval and sign-off**



Addendum 2, Security Systems Pre-Qualified Vendors

1. City of Brampton Security Services maintains a list of pre-qualified vendors for all security systems. These are the only vendors who can be used for these projects
2. Please note that there a **different types of systems vendors are pre-qualified for**. Not all vendors can work on all systems
3. Below is the current list of pre-qualified electronic Security vendors

<u>Company and Contact Information</u>	<u>Access Control, CCTV and Intrusion Alarms¹</u>	<u>DES, Intercoms, and Mass Notification²</u>
<p>M&R Security Inc. Address: 46-16 Regan Road, Brampton, ON L7A 1C1 Contact: Amy Martinez Email: amy@mnrsecurity.ca Phone: (905) 216-6424</p>		
<p>V.S.I. Inc. Address: 2650 Meadowvale Blvd, Unit #3, Mississauga, On L5N 6M5 Contact: Len Todaro Email: lentodaro@vistasecurity.com Phone: (905) 858-8211</p>		
<p>Vipond Address: 6380 Vipond Road, Mississauga, On L5T 1A1 Contact: Don Connor Email: don.connor@vipond.ca Phone: (416) 458-1990</p>		

¹ RBH Axiom, March Networks, DSC

² Commend

<p>Paladin Technologies Inc. Address: 1277 East Georgia Street, Vancouver, British Columbia V6A 2A9 Email: bids@paladintechnologies.com Phone: (604) 216-3585</p>		
<p>SSN networks Inc. Address: #24,1295Eglinton Avenue East, Mississauga, On L4W 3E6 Contact: Ashish Kaushal Email: ashish.kaushal@ssnnetworks.com Phone: (647) 300-9194</p>		
<p>Capital Fire and Security Inc. Address: 52-665 Millway Avenue Unit 52, Concord, On L4K 3T8 Contact: Dino Abballe Email: dino@capitalfireandsecurity.ca Phone: (906) 660-0007</p>		
<p>Colossus Security Inc. Address: 55-3176Ridgeway Drive, Mississauga, On L5L 1K7 Contact: Jarrod Budd Email: jbudd@colossussecurty.com Phone: (888) 204-8833</p>		

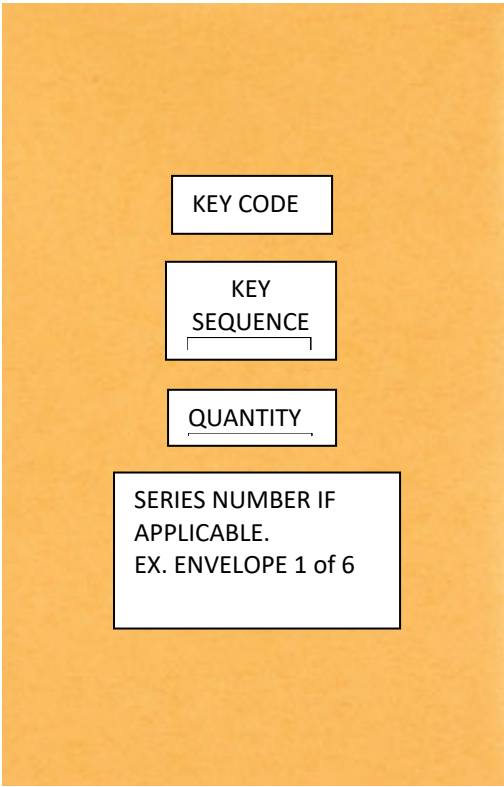
4. Medeco M3 Hardware can be order through any Medeco Security Centre (MSC) who is in good standing. A current list of MSC sais a available at the Medeco Dealer Locator [site](#)

KEY STAMPING REQUIREMENTS

All Medeco M3 keys will be required to follow the stamping pattern as what is shown below; all key cuts start at the Key Sequence 1 and will continue the numerical pattern. The Key Code will follow the Key Hierarchy that will be provided by the City of Brampton. The Registration Series will be the same for the building they will be cutting from.



All Medeco M3 keys will be provided to the City of Brampton in an envelope with the information below, printed directly on the envelope or alternatively on a sticker affixed to the envelope. If there are multiple of the same Key Code, one envelope will be used for each Key Sequence and envelopes are to be sealed.



DRAWING LIST - PHYSICAL SECURITY STANDARDS

Sheet No.	Sheet Name	Description	Sheet Issue Date
TYP-000	TITLE SHEET	Drawing List	03/26/19
TYP-NVR	NVR	Rack Mounted NVR	03/26/19
TYP-RK1	Rack #1	Full Height Rack	03/26/19
TYP-RK2	Rack #2	Half Height Rack	03/26/19
TYP-RK3	Rack #3	Wall Mount Rack	03/26/19
TYP-C01	Indoor Dome Camera (IP)	Interior IP Dome Camera, Recessed	03/26/19
TYP-C02	Outdoor Dome Camera (IP)	Exterior IP Dome Camera, Wall Mount	03/26/19
TYP-C03	Indoor PTZ (IP)	Interior IP PTZ, Recessed	03/26/19
TYP-C04	Outdoor PTZ (IP)	Exterior IP PTZ, Corner Mount	03/26/19
TYP-C05	Multi-Sensor Camera (IP)	Exterior Multi-Sensor Axis Q60 Series, Wall Mount	03/26/19
TYP-D01	Single Door - Electric Strike	Single Door - ES, SA, CR, CC, REX	03/26/19
TYP-D02	Double Door - Electric Strike	Double Door - ES, SA, CR, CC, REX	03/26/19
TYP-D03	Single Door - Maglock	Single Door - ML, SA, CR, CC, EB	03/26/19
TYP-D04	Double Door - Maglock	Double Door - ML, SA, CR, CC, EB	03/26/19
TYP-I01	Washroom Intercom	ADA Washroom Intercom	03/26/19
TYP-T01	Alarm Panel Integration	RBH/DSC Interface	03/26/19
TYP-T02	Maglock Riser - Typical	OBC Maglock Typical	03/26/19



Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

TITLE: Security Device Library
Sheet List

Date: 26MAR19	Scale: NTS	Project #:
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Drawing # : 2019-COB-TYP-000



Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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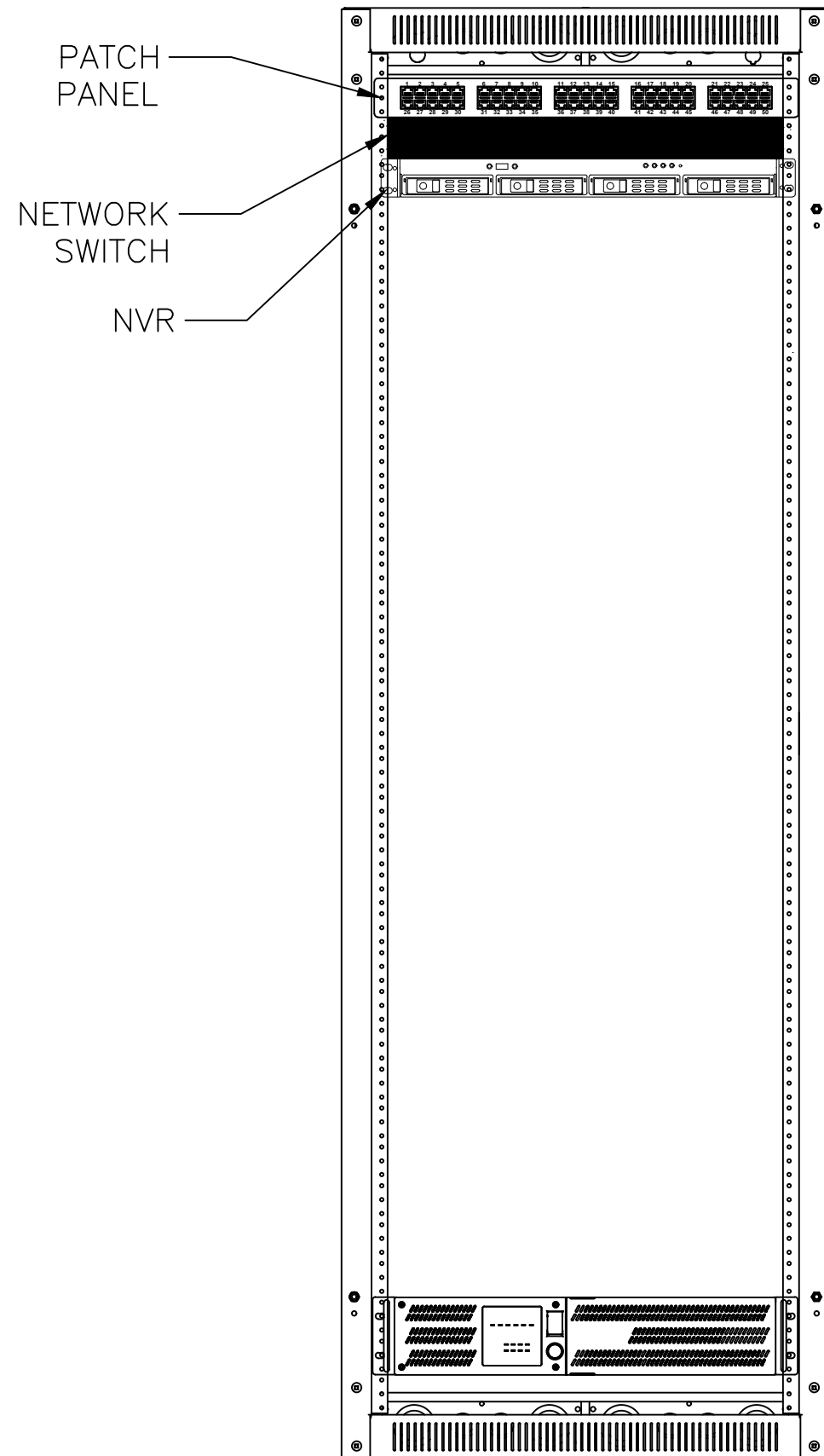
PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

TITLE: Security Device Library
CCTV Devices
Rack Mount NVR

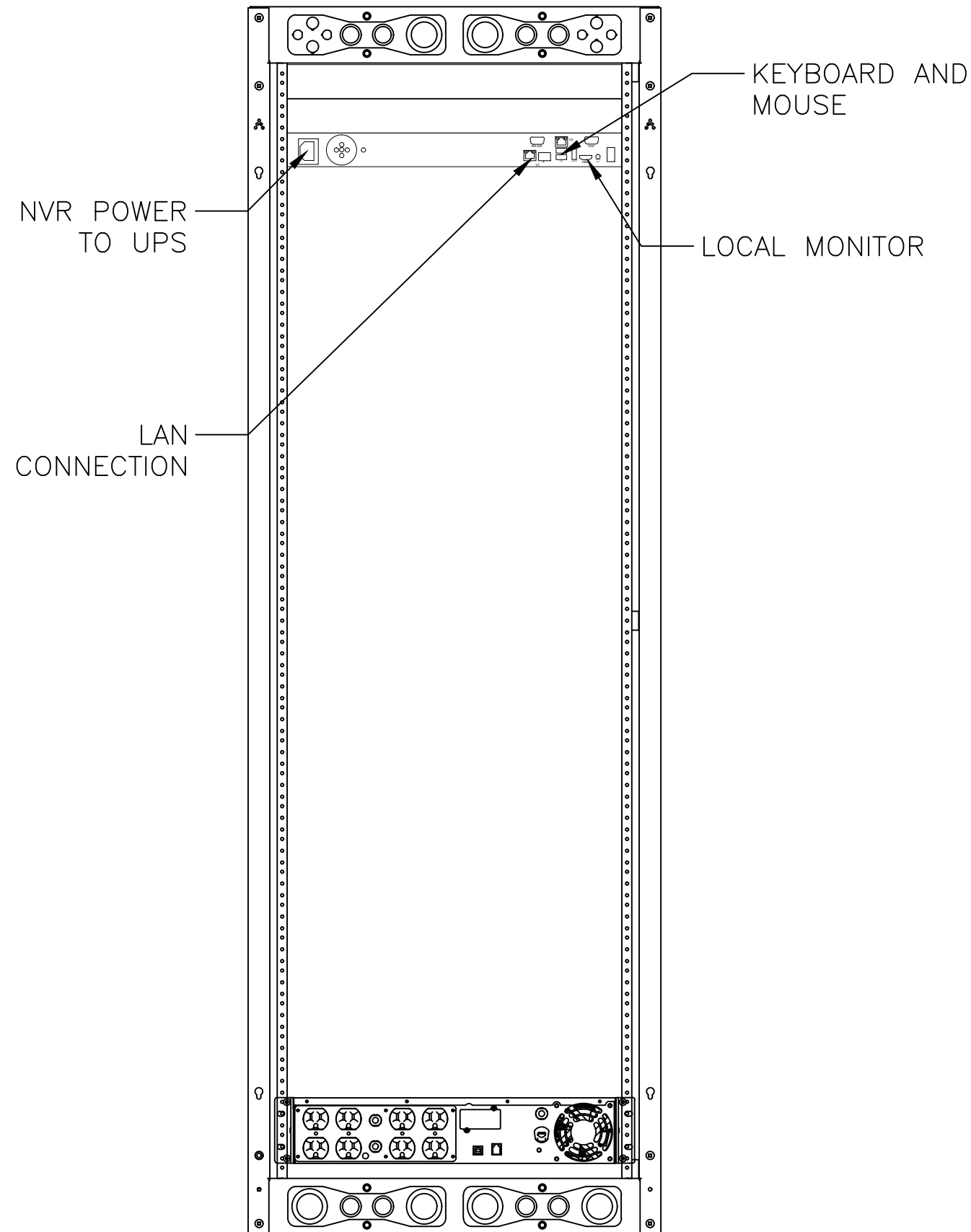
Date: 26MAR19	Scale: NTS	Project #:
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Drawing # : 2019-COB-TYP-NVR

FRONT VIEW



REAR VIEW





Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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CONSULTANT

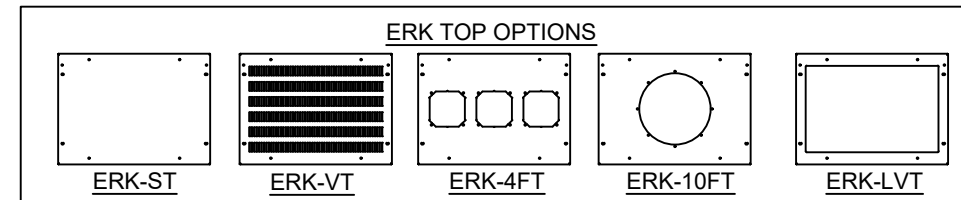
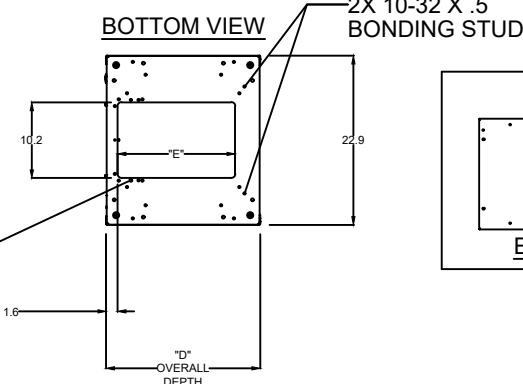
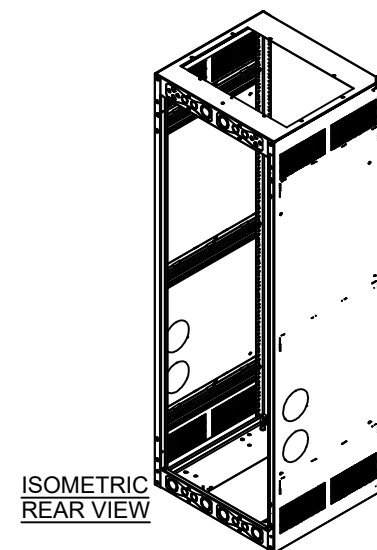
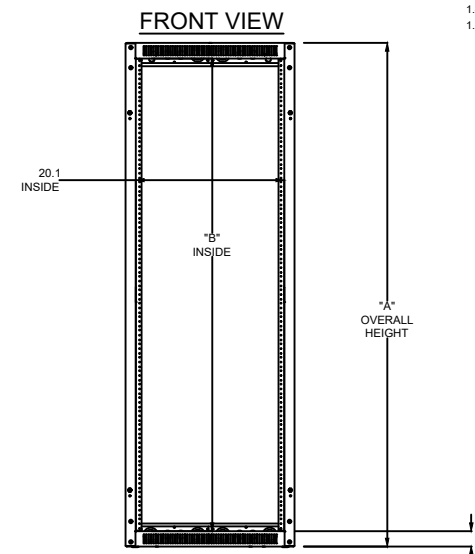
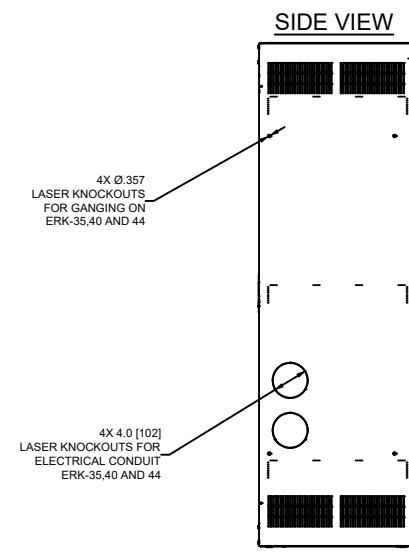
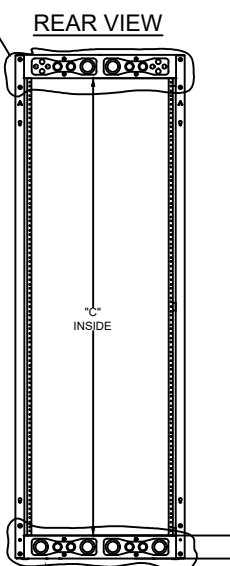
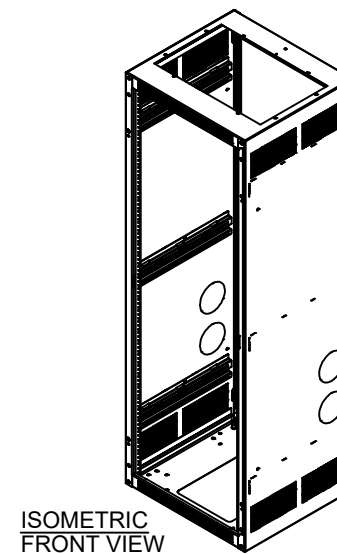
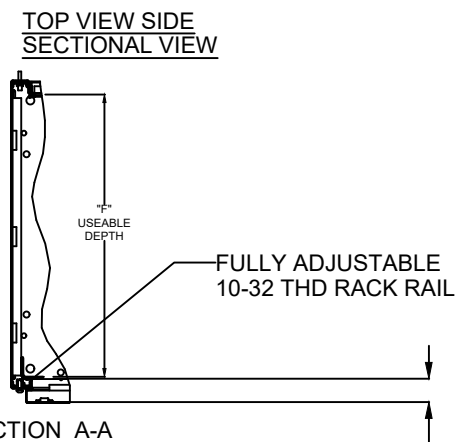
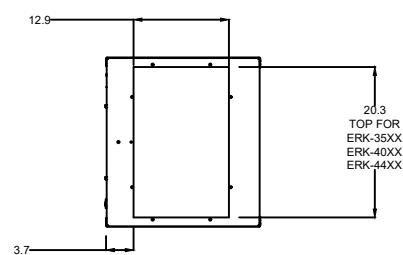
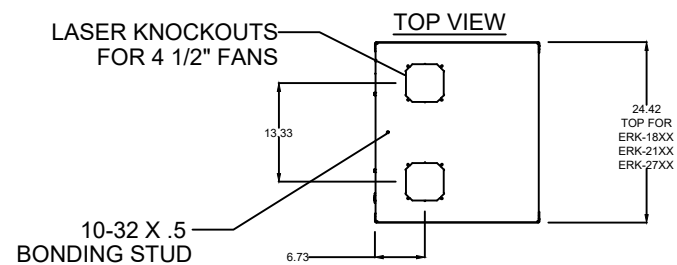
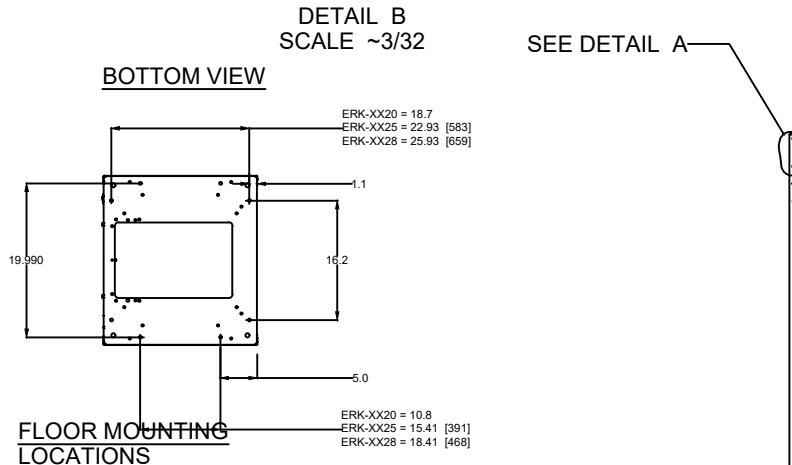
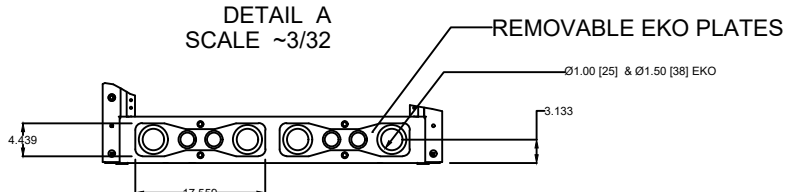
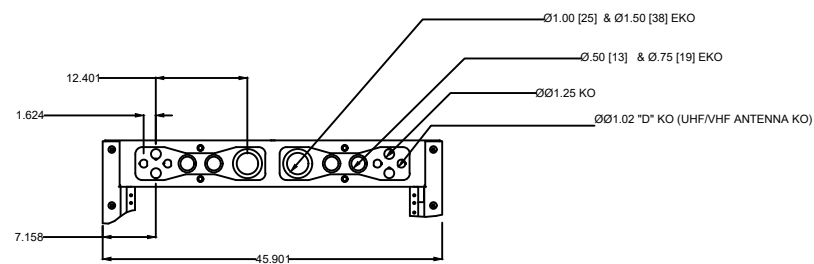
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PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

TITLE: Security Device Library
Infrastructure Devices
Full Height Rack -RK1

Date: 26MAR19	Scale: NTS	Project #:
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Drawing # : 2019-COB-TYP-RK1

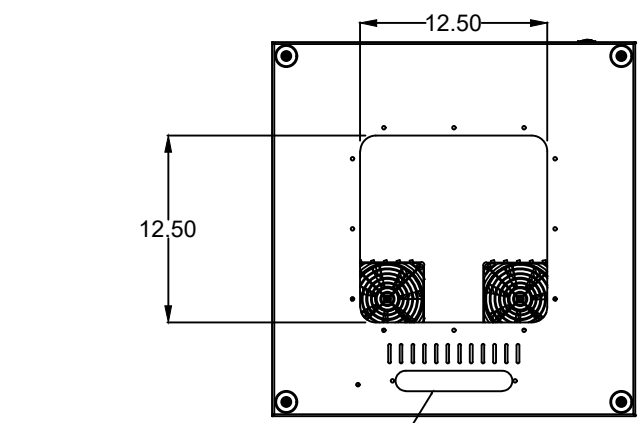
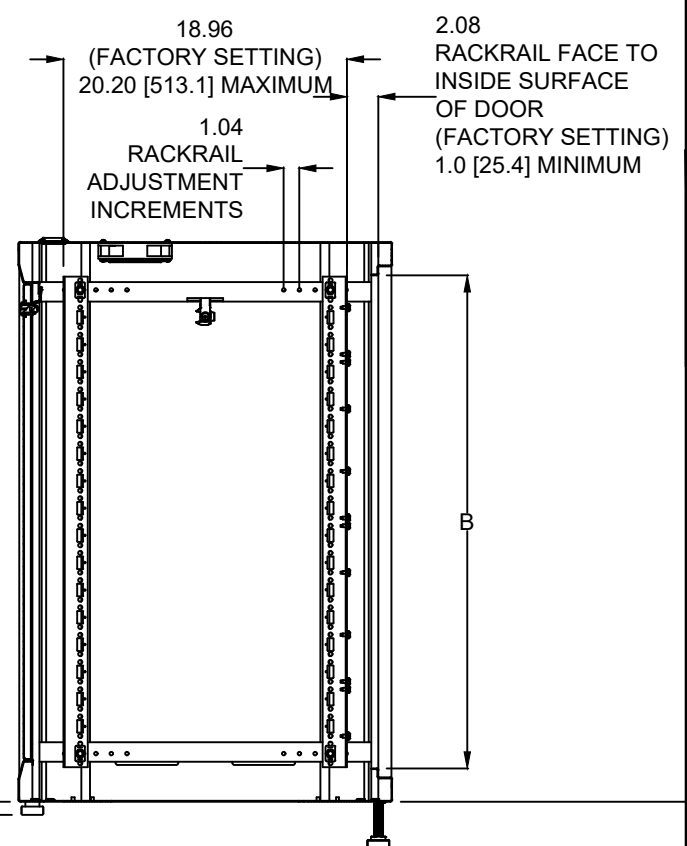
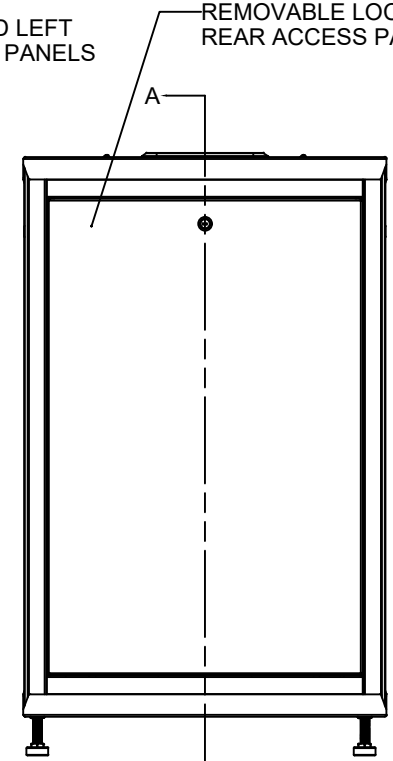
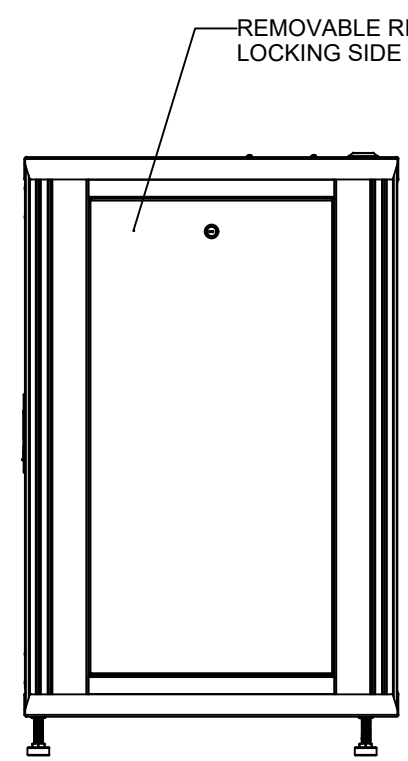
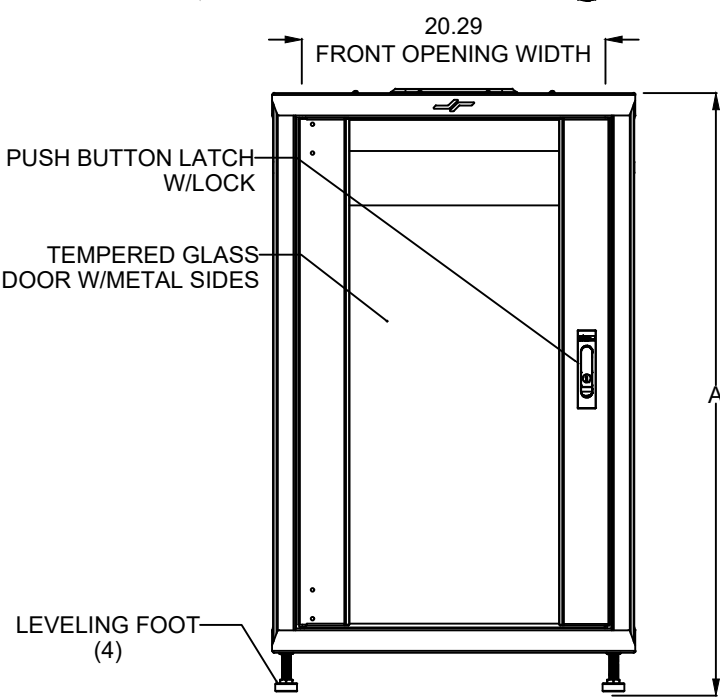
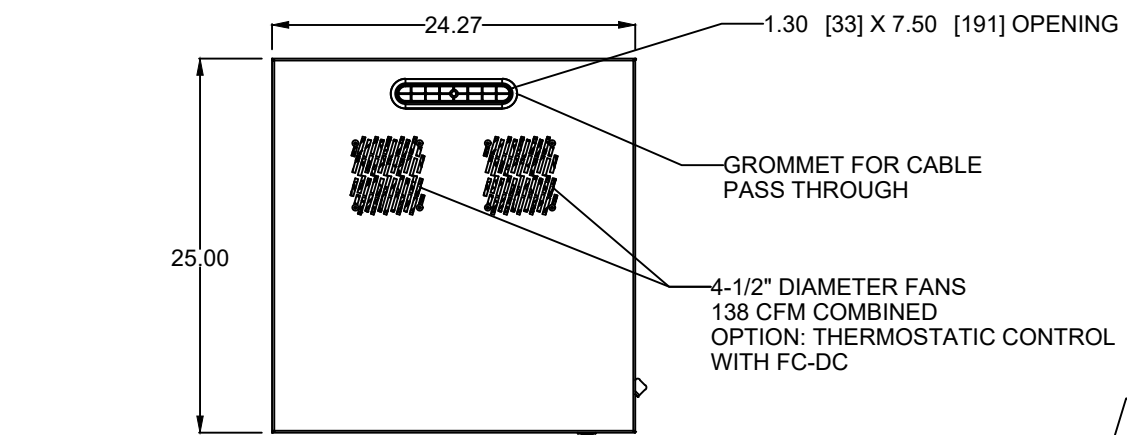


NOTE: ALL DIMENSIONS ARE GIVEN IN FORMAT IN[MM]

MODEL #	"A" OVERALL HEIGHT	"B" INSIDE HEIGHT	"C" INSIDE HEIGHT	"D" OVERALL DEPTH	"E" OPENING DEPTH	"F" USABLE DEPTH
ERK-1820	35.63 [905]	31.63 [803]	29.63 [753]	20.00 [387]	15.25 [387]	18.47 [469]
ERK-2120	40.88 [1038]	36.88 [937]	34.88 [886]	20.00 [387]	15.25 [387]	18.47 [469]
ERK-2720	51.38 [1305]	47.38 [1203]	45.38 [1153]	20.00 [387]	15.25 [387]	18.47 [469]
ERK-3520	65.38 [1661]	61.38 [1559]	59.38 [1508]	20.00 [387]	15.25 [387]	18.47 [469]
ERK-4020	74.13 [1883]	70.13 [1781]	68.13 [1731]	20.00 [387]	15.25 [387]	18.47 [469]
ERK-4420	81.13 [2061]	77.13 [1959]	75.13 [1908]	20.00 [387]	15.25 [387]	18.47 [469]
ERK-1825	35.63 [905]	31.63 [803]	29.63 [753]	25.00 [635]	20.25 [514]	23.47 [596]
ERK-2125	40.88 [1038]	36.88 [937]	34.88 [886]	25.00 [635]	20.25 [514]	23.47 [596]
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ERK-3528	65.38 [1661]	61.38 [1559]	59.38 [1508]	28.00 [711]	23.25 [591]	26.47 [672]
ERK-4028	74.13 [1883]	70.13 [1781]	68.13 [1731]	28.00 [711]	23.25 [591]	26.47 [672]
ERK-4428	81.13 [2061]	77.13 [1959]	75.13 [1908]	28.00 [711]	23.25 [591]	26.47 [672]



REV	DESCRIPTION	REV BY	REV DATE	APP'D BY	DATE APP.
-	PRODUCTION RELEASE	///	////	LM	11/05/12
A	EC-5354 UPDATE TO RACKRAIL	RHP	12/17/12	LM	12/17/12
B	EC-6286 - ALIGN DESIGN WITH QAR/MMR PROJECT	LM	06/25/14	JJP	07/07/14
C	EC-7396: COLUMNS 'A' AND 'B' HEIGHT INCREASE BY .040" [1MM]	RAR	01/28/15	LM	01/30/15
D	EC-6579 - CHANGE CASTER MTG HOLES TO SHOWEL LANCE	JIP	04/13/15	NC	04/13/15
E	EC-8922 SIDE/REAR PANEL CHANGED	LM	10/31/16	NC	11/04/16



NOTE:
1) DIMENSIONS SHOWN IN INCHES [MM]

MODEL NUMBER	WEIGHT RATING	A OVERALL HEIGHT	B FRONT OPENING HEIGHT	RACK SPACES
RCS-1824	500 lbs/227 kg	38.66 [982]	31.63 [803]	18 (31.50")
RCS-2724	750 lbs/340 kg	54.41 [1382]	47.38 [1203]	27 (47.25")
RCS-3524	1000 lbs/454 kg	68.41 [1738]	61.38 [1559]	35 (61.25")
RCS-4224	1,200 lbs/544 kg	80.66 [2049]	73.63 [1870]	42 (73.50")

USED ON: RCS-XX24
NEXT ASSY: --
MATERIAL: SEE COMPONENTS
FINISH: -- --

Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review
1.1	9JUL19	TK	Removed Optional Casters

Drawn By: ZB1	Approved By: SB	Revision#: 1.1
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CONSULTANT

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PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

TITLE: Security Device Library
Infrastructure Devices
Half Height rack - RK2

Date: 26MAR19	Scale: NTS	Project #:
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Drawing # : 2019-COB-TYP-RK2



Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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CONSULTANT

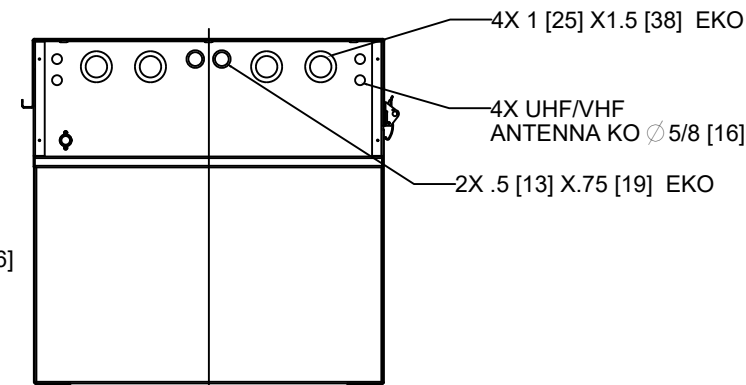
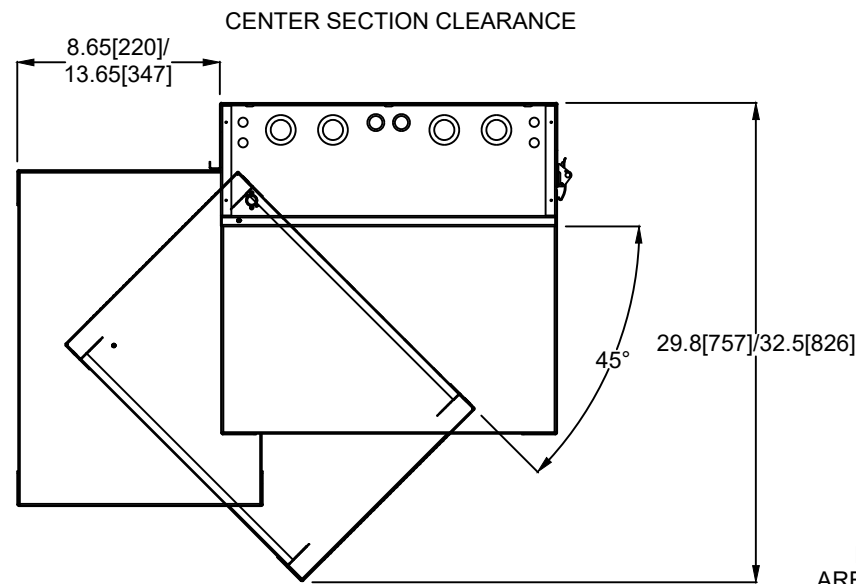
Disclaimer

PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

TITLE: Security Device Library
Infrastructure Devices
Wall Rack - RK3

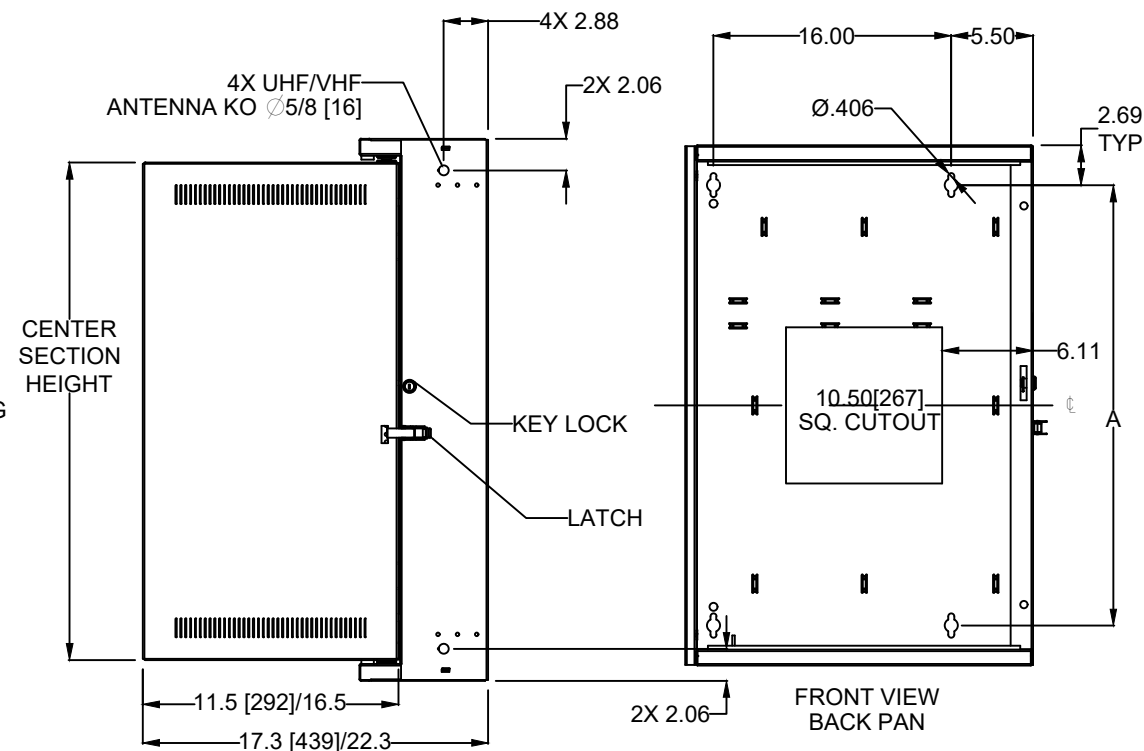
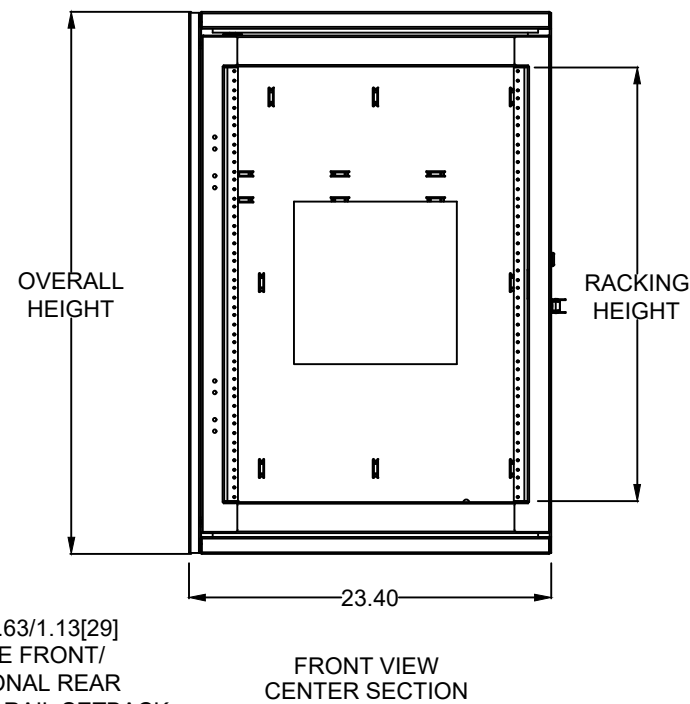
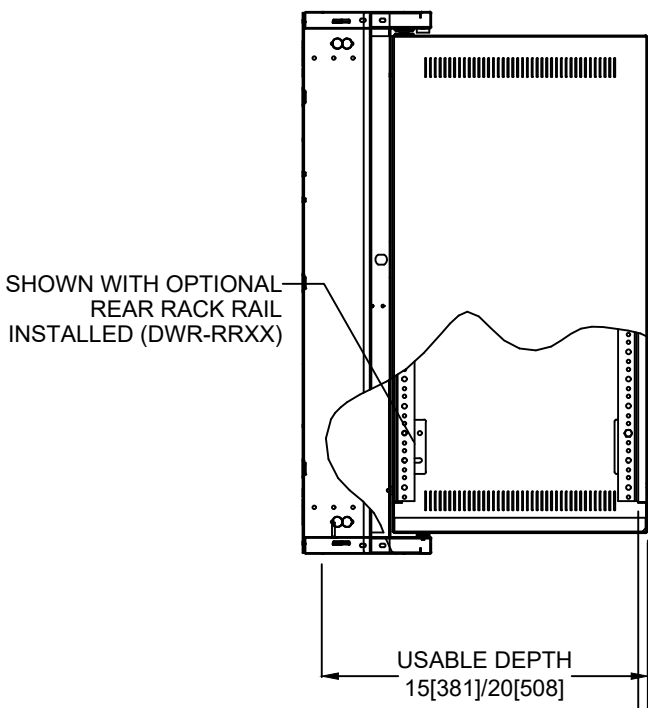
Date: 26MAR19	Scale: NTS	Project #:
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Drawing # : 2019-COB-TYP-RK3



TOP VIEW
KNOCKOUTS PICTURED IN TOP VIEW
ARE ALSO LOCATED ON THE BOTTOM VIEW

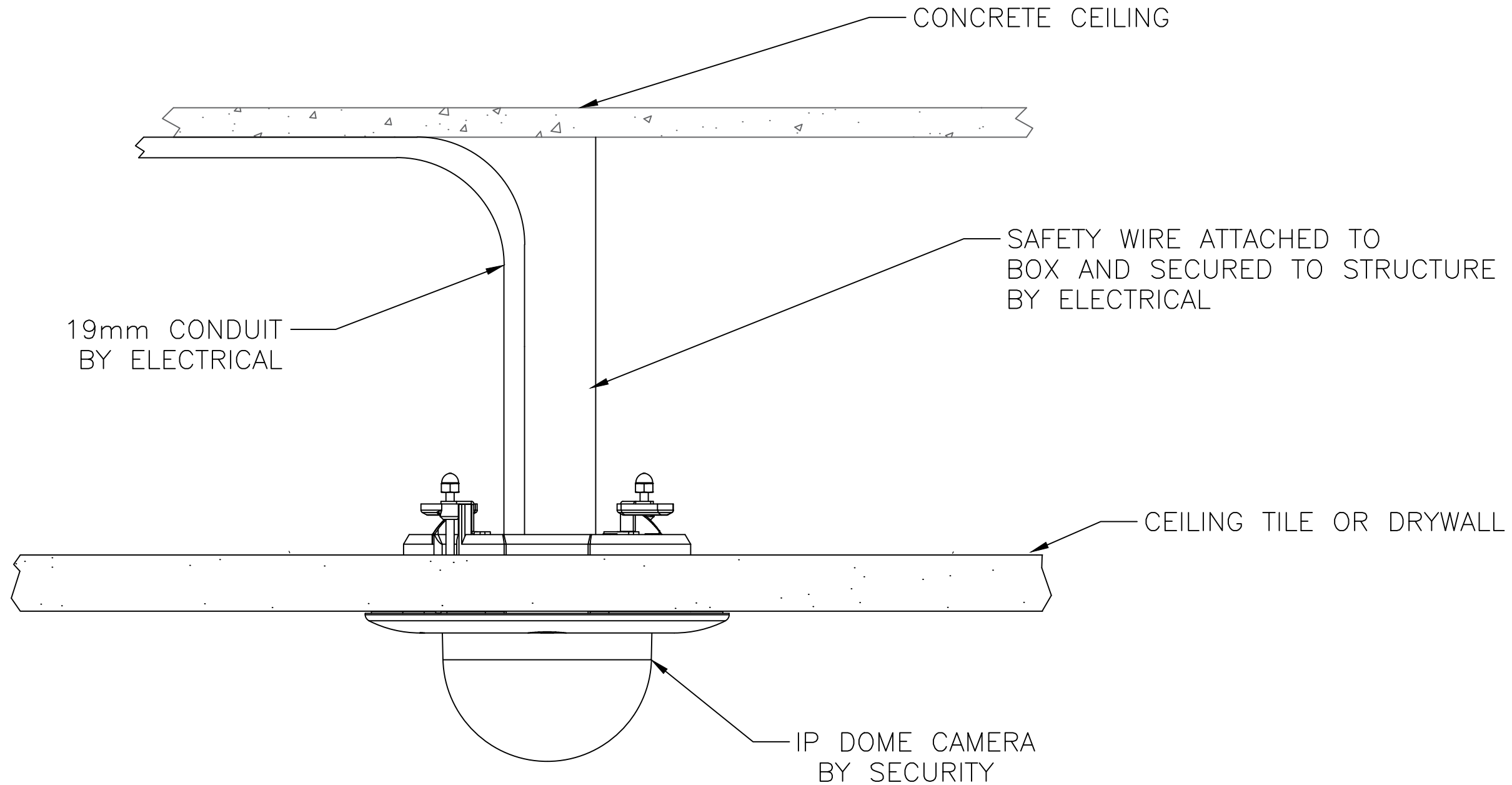
	OVERALL HEIGHT	CENTER SECTION HEIGHT	RACKING HEIGHT	RACK SPACES	WEIGHT CAPACITY	A
EW-8-17	21.00[533]	18.13 [460]	14.00[356]	8 SP	150 lbs	15.625[396.9]
EW-8-22	21.00[533]	18.13 [460]	14.00[356]	8 SP	150 lbs	15.625[396.9]
EW-10-17	24.50[622]	21.63 [549]	17.50[445]	10 SP	150 lbs	19.125[485.8]
EW-10-22	24.50[622]	21.63 [549]	17.50[445]	10 SP	150 lbs	19.125[485.8]
EW-12-17	28.00[711]	25.13 [638]	21.00[533]	12 SP	150 lbs	22.625[574.7]
EW-12-22	28.00[711]	25.13 [638]	21.00[533]	12 SP	150 lbs	22.625[574.7]
EW-16-17	35.00[889]	32.13 [816]	28.00[711]	16 SP	150 lbs	29.625[752.5]
EW-16-22	35.00[889]	32.13 [816]	28.00[711]	16 SP	150 lbs	29.625[752.5]



NOTES:
1) 17 [432] AND 22 [559] DEEP MODELS ARE REPRESENTED IN THIS DRAWING. (EWR-XX-17) / (EWR-XX-22)
2) DIMENSIONS SHOWN AS in.[mm]

ALL CABLES TO DESIGNATED NETWORK SWITCH BY SECURITY CONTRACTOR. CONDUIT BY ELECTRICAL, TO APPROPRIATE CABLE TRAY OR NEAREST PANEL AS REQUIRED

ACTUAL CAMERA HEIGHT TO BE FIELD VERIFIED. ADJUST HEIGHT IF LIGHT FIXTURES, VENTILATION DUCTS, OR OTHER ELEMENTS PREVENT A CLEAR AND UNOBSTRUCTED VIEW.



Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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CONSULTANT

Disclaimer

PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

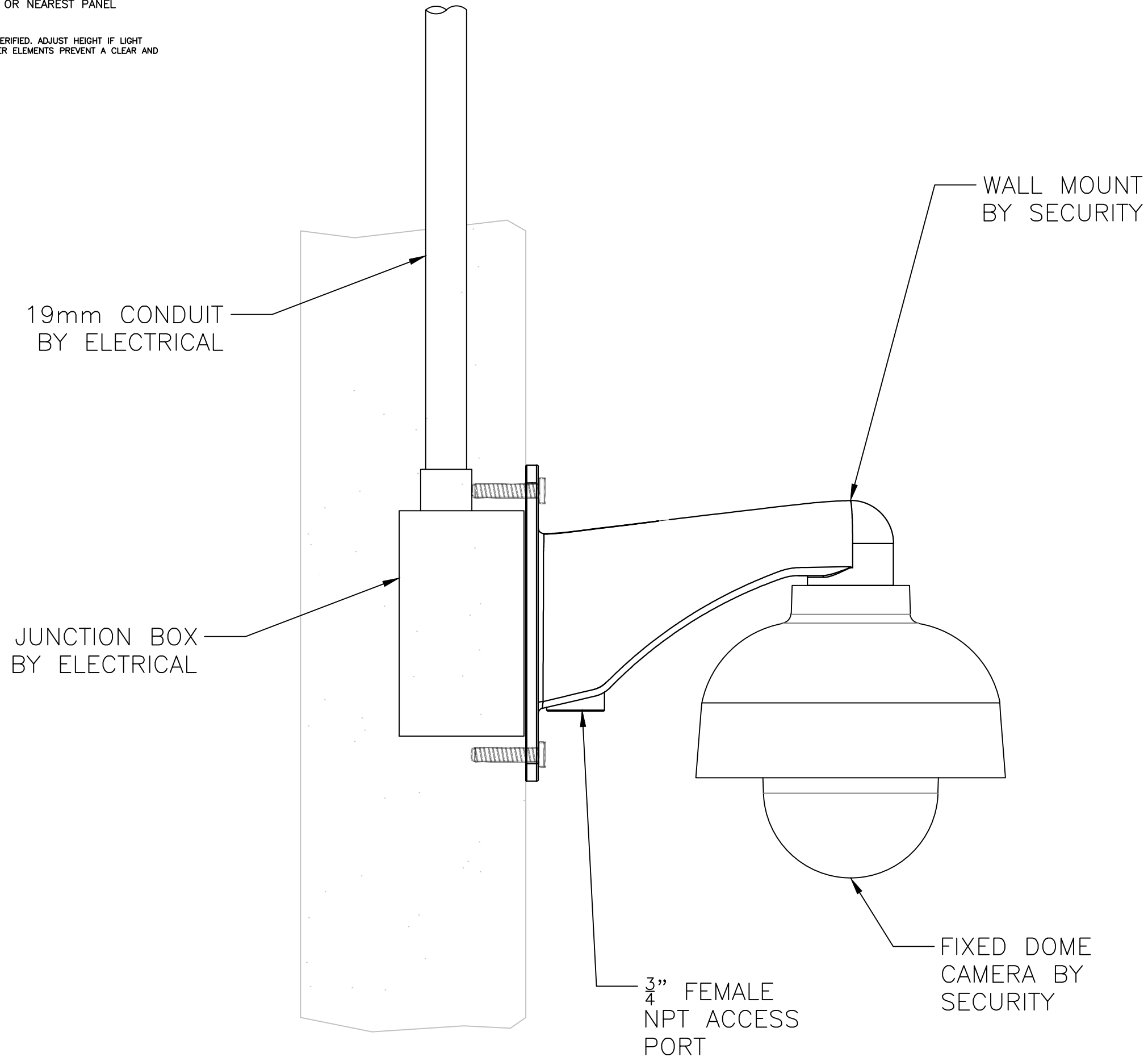
TITLE: Security Device Library
CCTV Devices
Interior IP Dome - Recessed - C01

Date: 26MAR19	Scale: NTS	Project #:
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Drawing # : 2019-COB-TYP-C01

ALL CABLES TO DESIGNATED NETWORK SWITCH BY SECURITY CONTRACTOR. CONDUIT BY ELECTRICAL, TO APPROPRIATE CABLE TRAY OR NEAREST PANEL AS REQUIRED

ACTUAL CAMERA HEIGHT TO BE FIELD VERIFIED. ADJUST HEIGHT IF LIGHT FIXTURES, VENTILATION DUCTS, OR OTHER ELEMENTS PREVENT A CLEAR AND UNOBSTRUCTED VIEW.,



Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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CONSULTANT

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PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

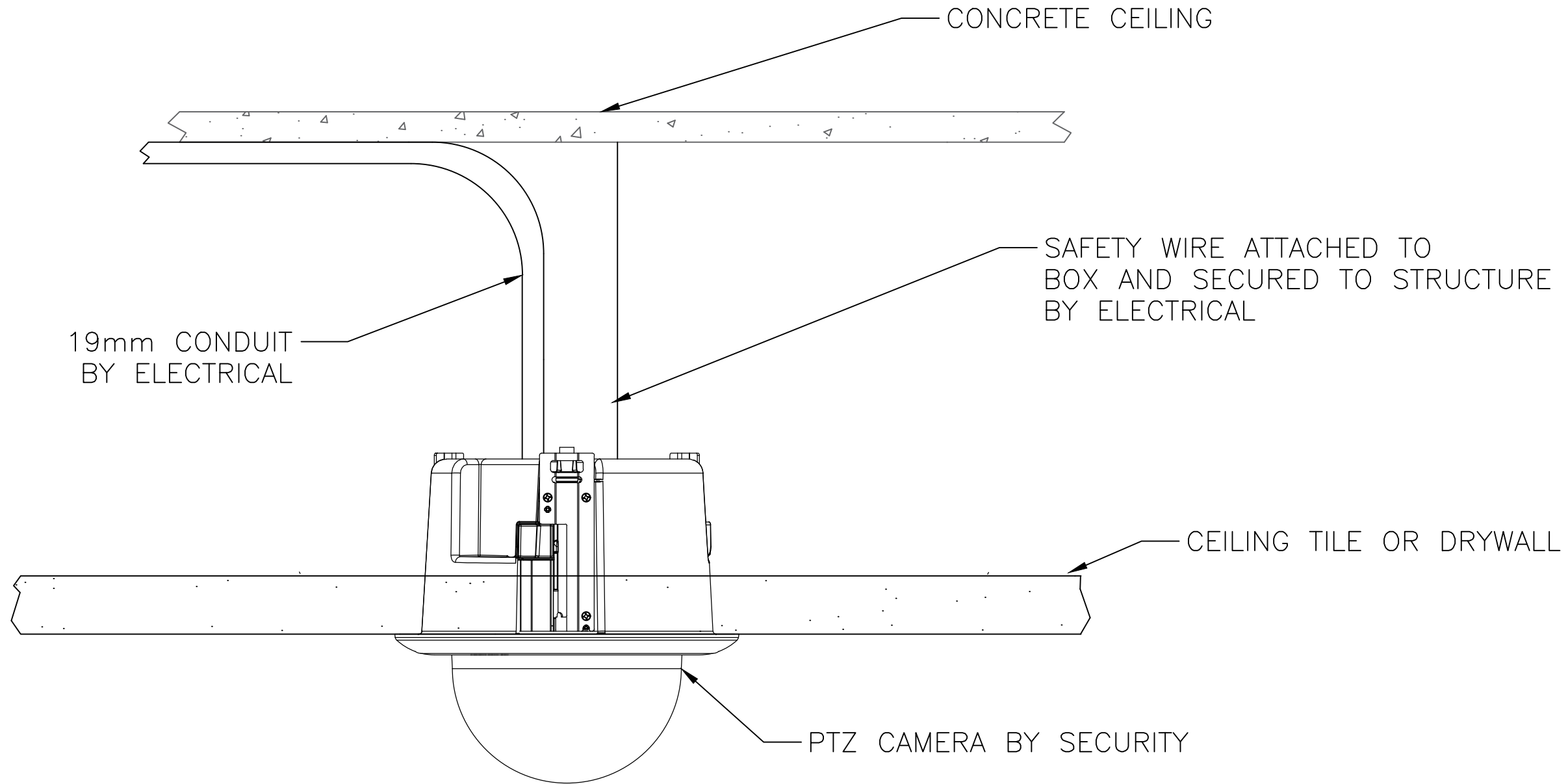
TITLE: Security Device Library
CCTV Devices
Exterior IP Dome - Wall Mount - C02

Date: 26MAR19	Scale: NTS	Project #:
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Drawing # : 2019-COB-TYP-C02

ALL CABLES TO DESIGNATED NETWORK SWITCH BY SECURITY CONTRACTOR. CONDUIT BY ELECTRICAL, TO APPROPRIATE CABLE TRAY OR NEAREST PANEL AS REQUIRED

ACTUAL CAMERA HEIGHT TO BE FIELD VERIFIED. ADJUST HEIGHT IF LIGHT FIXTURES, VENTILATION DUCTS, OR OTHER ELEMENTS PREVENT A CLEAR AND UNOBSTRUCTED VIEW.



Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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CONSULTANT

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PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

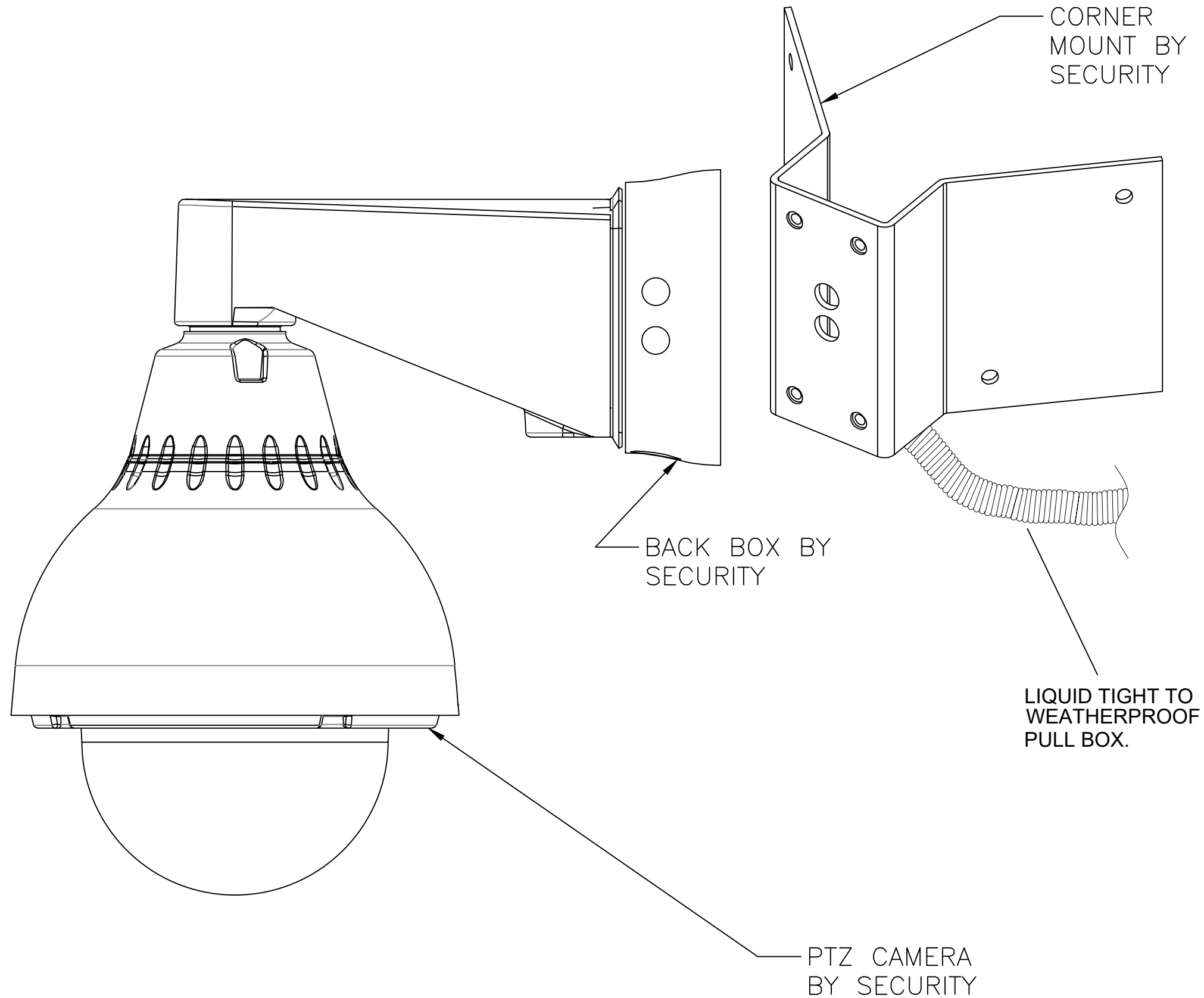
TITLE: Security Device Library
CCTV Devices
Interior IP PTZ - Recessed - C03

Date: 26MAR19	Scale: NTS	Project #:
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Drawing # : 2019-COB-TYP-C03

ALL CABLES TO DESIGNATED NETWORK SWITCH BY SECURITY CONTRACTOR. CONDUIT BY ELECTRICAL, TO APPROPRIATE CABLE TRAY OR NEAREST PANEL AS REQUIRED

ACTUAL CAMERA HEIGHT TO BE FIELD VERIFIED. ADJUST HEIGHT IF LIGHT FIXTURES, VENTILATION DUCTS, OR OTHER ELEMENTS PREVENT A CLEAR AND UNOBSTRUCTED VIEW.,



Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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CONSULTANT

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PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

TITLE: Security Device Library
CCTV Devices
Exterior IP PTZ - Corner Mount - C04

Date: 26MAR19	Scale: NTS	Project #:
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Drawing # : 2019-COB-TYP-C04



Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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CONSULTANT

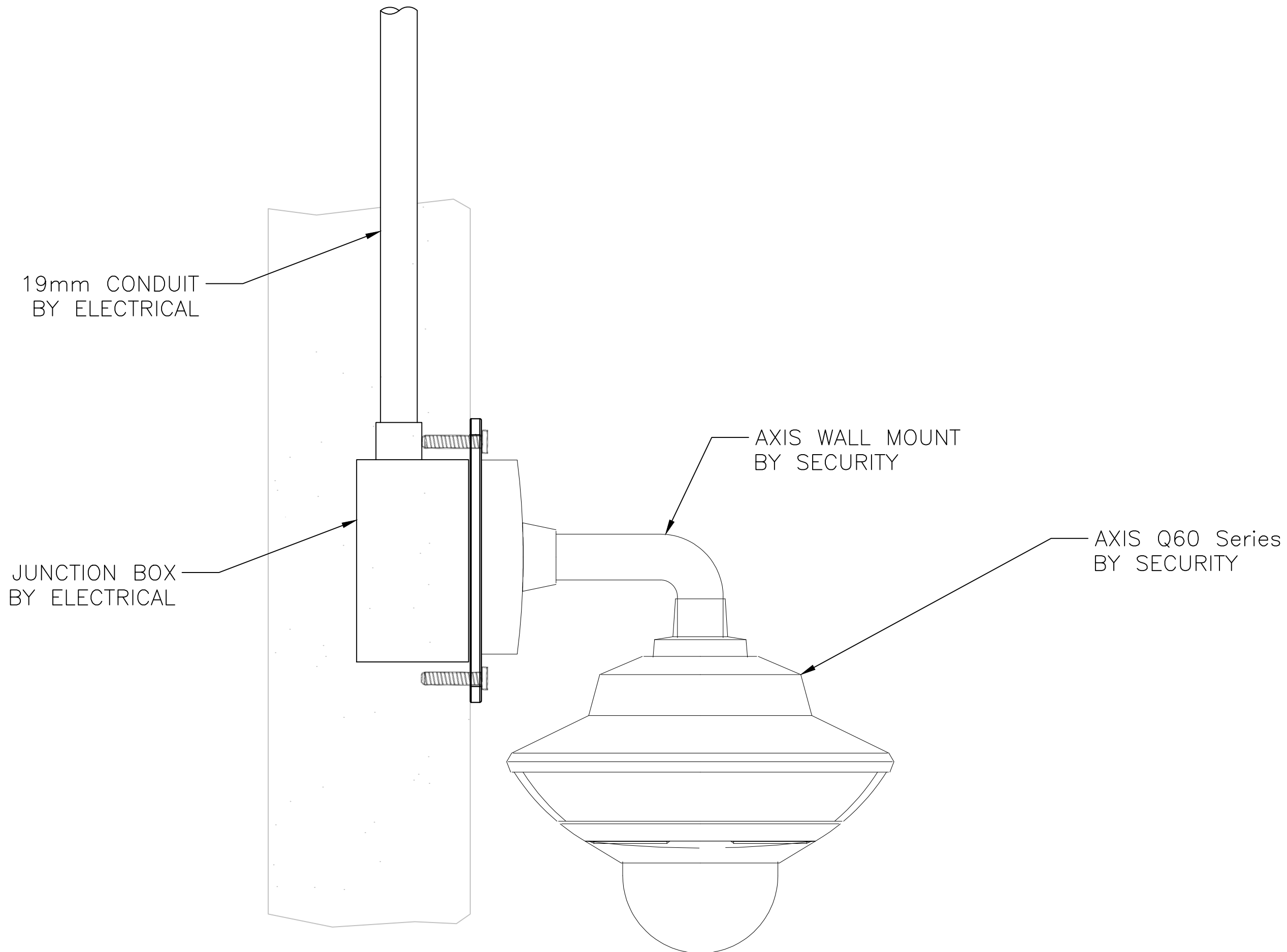
Disclaimer

PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

TITLE: Security Device Library
CCTV Devices
Exterior MultiSensor - Wall Mount - C05

Date: 26MAR19	Scale: NTS	Project #:
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Drawing # : 2019-COB-TYP-C05



CABLE IDENTIFICATION

Type	Description	Reference # FT4/FT6	Max Length
1	4 conductor, 22 awg, non shielded	8444 / 88444	500 FT
2	2 conductor, 18 awg, non shielded	9740 / 89740	500 FT
3	6 conductor, 22 awg, shielded with drain	8777 / 82777	500 FT
4	Category 6 Network cable	7927A / 7931A	300 FT
5	4 conductor (2 PAIR), 22 awg, individually shielded with drain	8723 / 82723	2000 FT

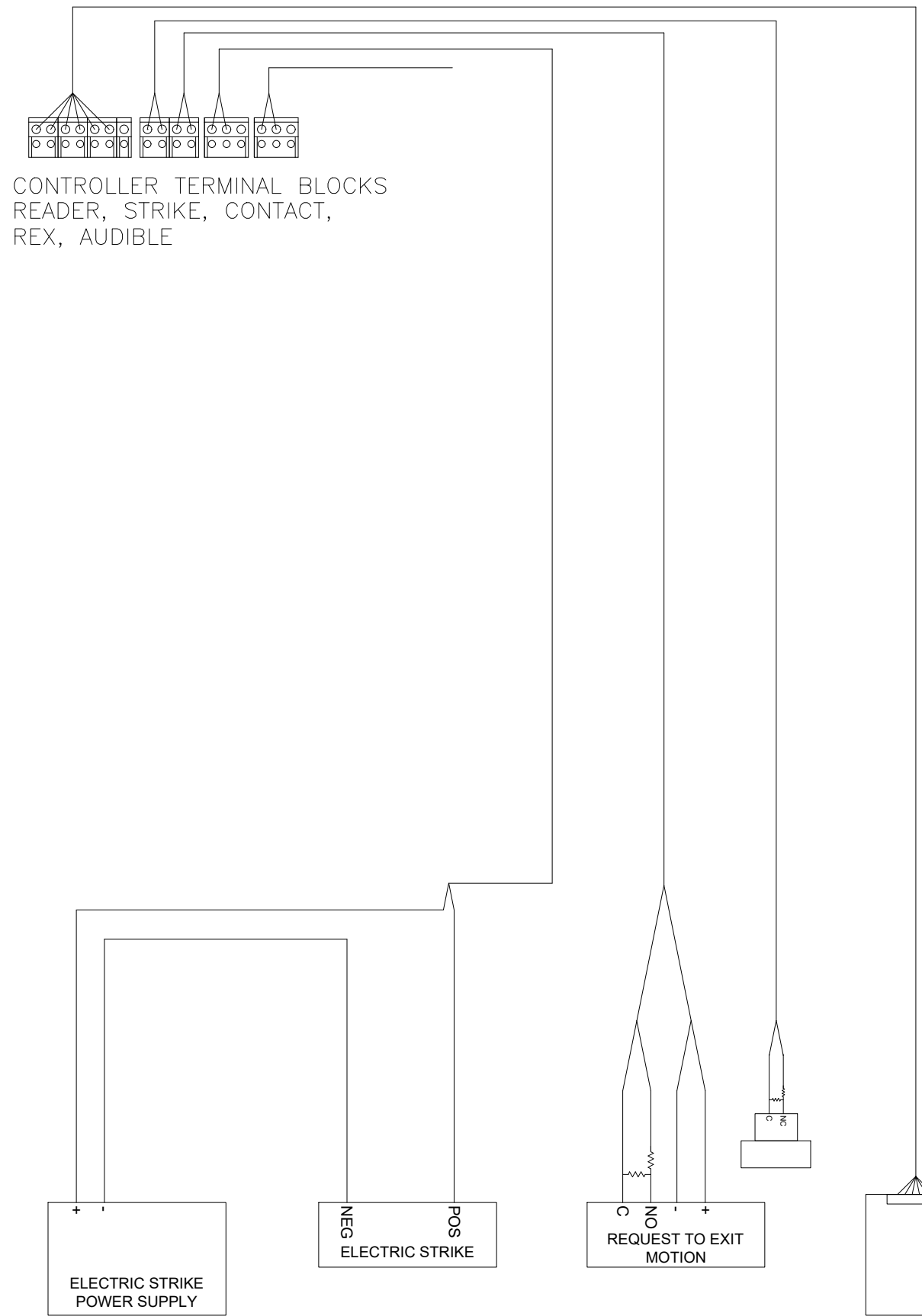
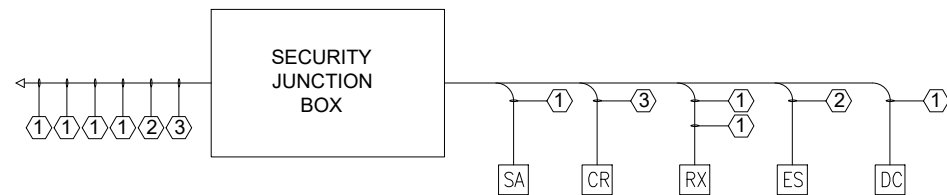
NOTES:

1. COORDINATE LOCKING HARDWARE WITH SECURITY. LOCKS BY DOOR HARDWARE.
2. DETAILS ARE FOR REFERENCE ONLY. SEE PLANS FOR SWING, DEVICE PLACEMENT, ETC.
3. FRAME MODIFICATIONS ARE BY DOOR HARDWARE.
4. ALL CONDUIT, FITTINGS, BACK BOXES ETC. BY ELECTRICAL.
5. DOOR CONTACTS REQUIRE 1" HOLE IN FRAMES AND DOORS PREPPED BY DOOR HARDWARE FOR 1076 CONTACT.

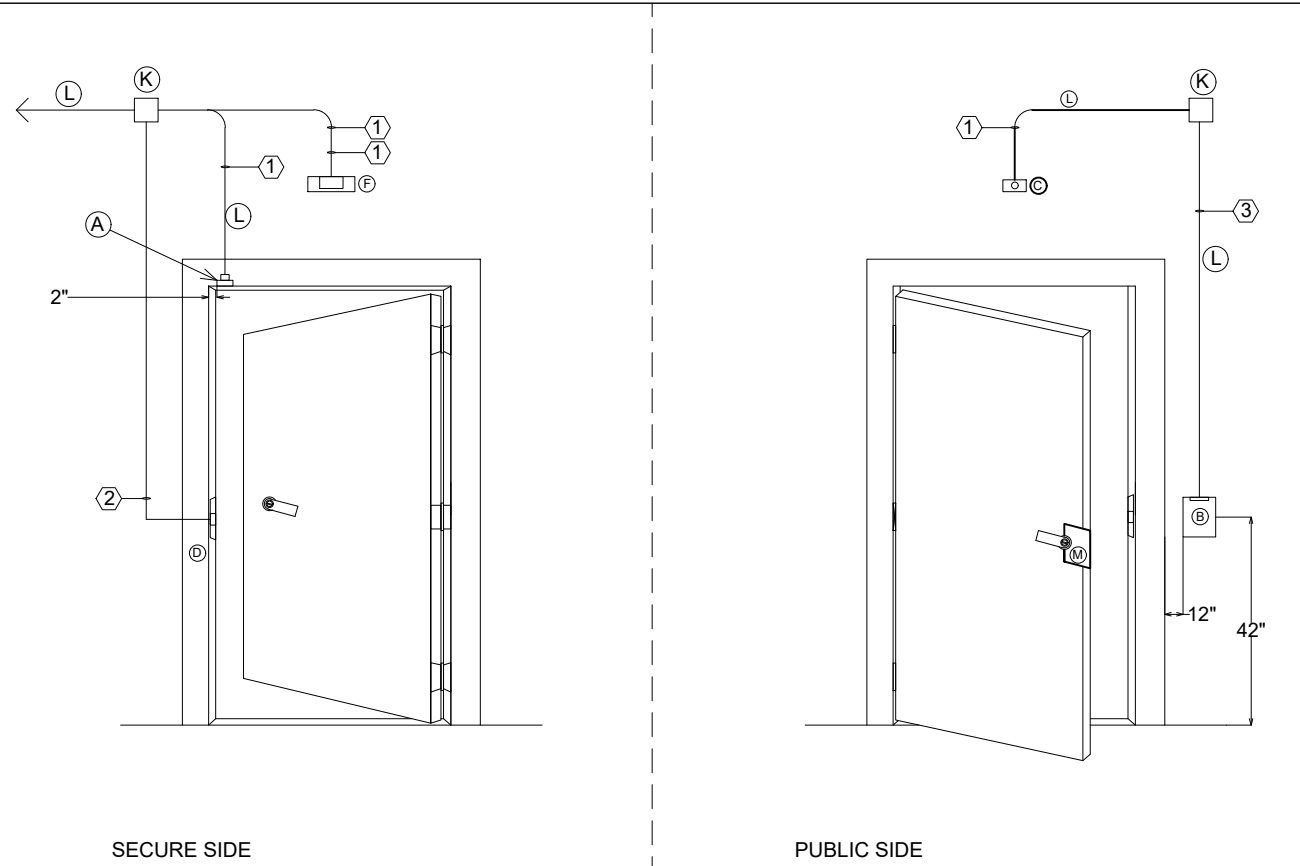


Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review



ALL CABLES TO ACCESS CONTROL PANEL BY SECURITY CONTRACTOR. CONDUIT BY ELECTRICAL, TO APPROPRIATE CABLE TRAY OR NEAREST PANEL AS REQUIRED



<p>Device Legend</p> <ul style="list-style-type: none"> Ⓐ DOOR CONTACT Ⓑ CARD READER Ⓒ LOCAL AUDIBLE Ⓓ DOOR STRIKE Ⓔ ELECTROMAGNETIC LOCK Ⓕ REQUEST TO EXIT MOTION DETECTOR Ⓖ EXIT BUTTON Ⓗ ELECTRIFIED HINGE Ⓘ ELECTRONIC LOCKSET (REX) 	<ul style="list-style-type: none"> Ⓚ 4" X 4" JUNCTION BOX Ⓛ 3/4" CONDUIT (MINIMUM) FROM JUNCTION BOX TO CONTROL EQUIPMENT Ⓜ LATCH GUARD Ⓝ DOOR OPERATOR Ⓞ DOOR OPERATOR INTERFACE NETWORK Ⓟ INTERCOM Ⓠ BIOMETRIC READER 	<ul style="list-style-type: none"> Ⓡ STOREROOM LOCKSET - NON ELECTRONIC
--	--	--

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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CONSULTANT

Disclaimer

PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

TITLE: Security Device Library
Access Devices
Single Door - ES,SA,CR,CC,REX

Date: 26MAR19	Scale: NTS	Project #:
Drawing # : 2019-COB-TYP-D01		

CABLE IDENTIFICATION

Type	Description	Reference # FT4/FT6	Max Length
1	4 conductor, 22 awg, non shielded	8444 / 88444	500 FT
2	2 conductor, 18 awg, non shielded	9740 / 89740	500 FT
3	6 conductor, 22 awg, shielded with drain	8777 / 82777	500 FT
4	Category 6 Network cable	7927A / 7931A	300 FT
5	4 conductor (2 PAIR), 22 awg, individually shielded with drain	8723 / 82723	2000 FT

NOTES:

1. COORDINATE LOCKING HARDWARE WITH SECURITY. LOCKS BY DOOR HARDWARE
2. DETAILS ARE FOR REFERENCE ONLY. SEE PLANS FOR SWING, DEVICE PLACEMENT, ETC
3. FRAME MODIFICATIONS ARE BY DOOR HARDWARE
4. ALL CONDUIT, FITTINGS, BACK BOXES ETC. BY ELECTRICAL
5. DOOR CONTACTS REQUIRE 1" HOLE IN FRAMES AND DOORS PREPPED BY DOOR HARDWARE FOR 1076 CONTACT



Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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CONSULTANT

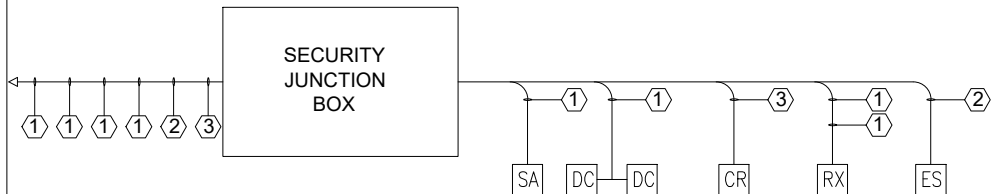
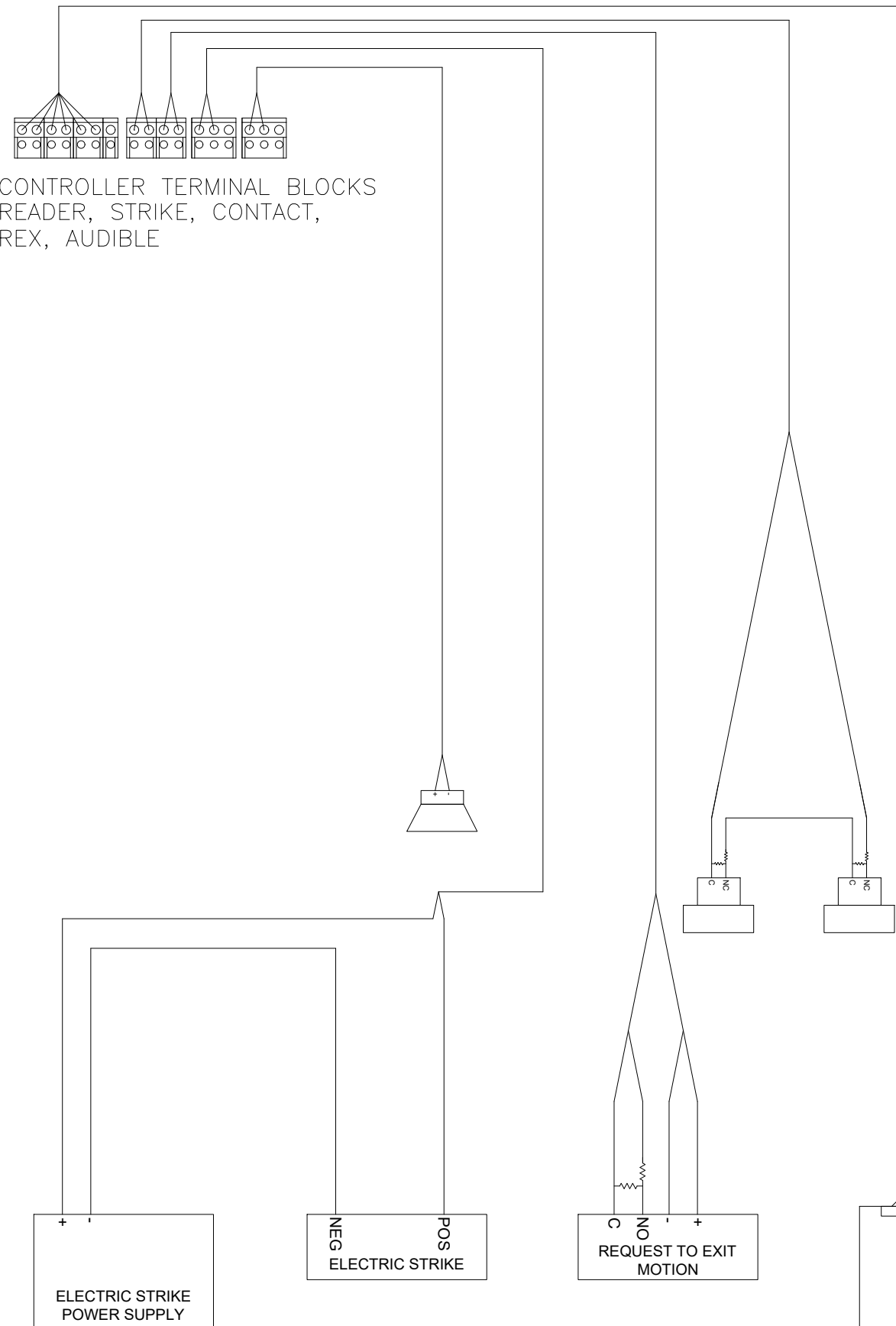
Disclaimer

PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

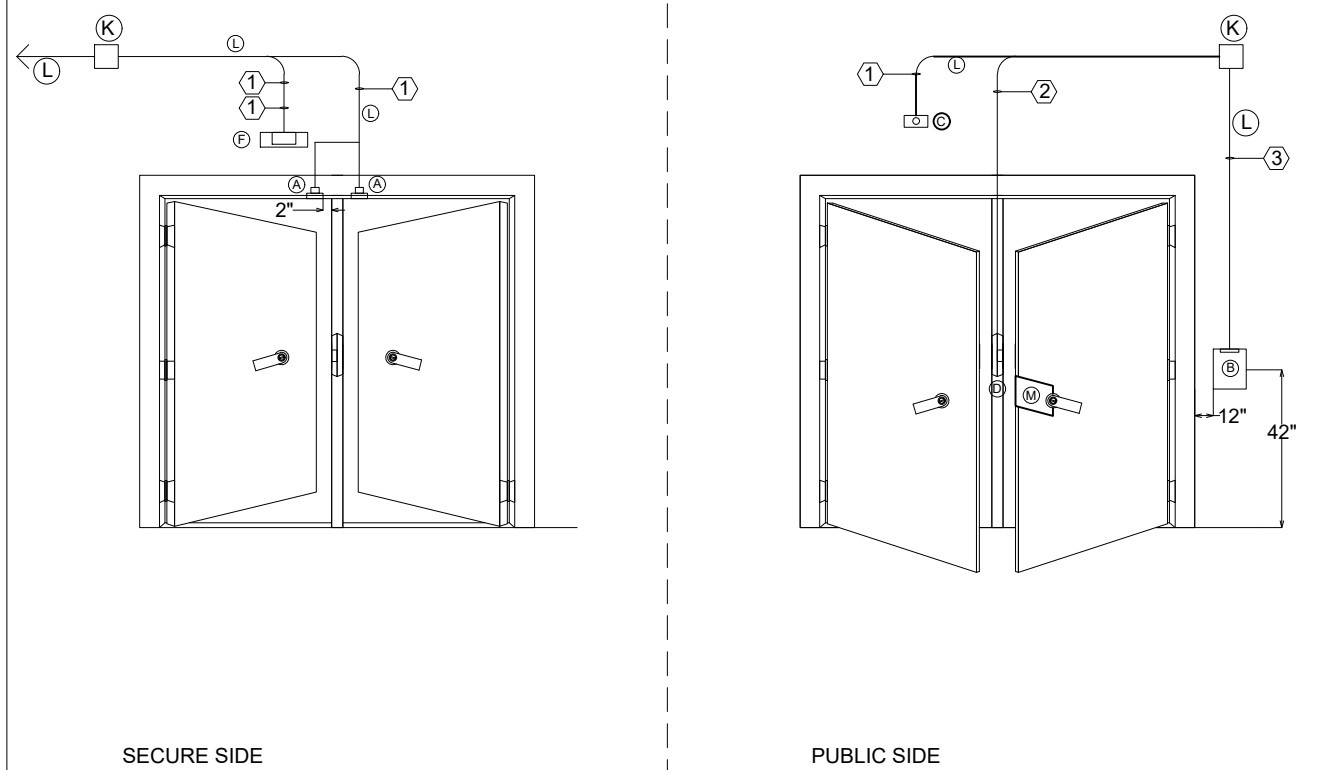
TITLE: Security Device Library
Infrastructure Devices
TYPE WRK (Wall Rack)

Date: 26MAR19	Scale: NTS	Project #:
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Drawing # : 2019-COB-TYP-WRK



ALL CABLES TO ACCESS CONTROL PANEL
BY SECURITY CONTRACTOR. CONDUIT BY ELECTRICAL,
TO APPROPRIATE CABLE TRAY OR NEAREST PANEL
AS REQUIRED



Device Legend (A) DOOR CONTACT (B) CARD READER (C) LOCAL AUDIBLE (D) DOOR STRIKE (E) ELECTROMAGNETIC LOCK (F) REQUEST TO EXIT MOTION DETECTOR (G) EXIT BUTTON (H) ELECTRIFIED HINGE (I) ELECTRONIC LOCKSET (REX)	(DC) DOOR CONTACT (CR) CARD READER (SA) LOCAL AUDIBLE (ES) DOOR STRIKE (ME) ELECTROMAGNETIC LOCK (RX) REQUEST TO EXIT MOTION DETECTOR (EB) EXIT BUTTON (TH) ELECTRIFIED HINGE (EL) ELECTRONIC LOCKSET (REX)	(J) STOREROOM LOCKSET - NON ELECTRONIC (K) 4" X 4" JUNCTION BOX (L) 3/4" CONDUIT (MINIMUM) FROM JUNCTION BOX TO CONTROL EQUIPMENT (M) LATCH GUARD (N) DOOR OPERATOR (O) DOOR OPERATOR INTERFACE NETWORK (P) INTERCOM (Q) BIOMETRIC READER	(SB) SECURITY SERVICES (CX) CITY OF X (C) CITY OF (BR) BRAMPTON
--	---	--	--

CABLE IDENTIFICATION

Type	Description	Reference # FT4/FT6	Max Length
1	4 conductor, 22 awg, non shielded	8444 / 88444	500 FT
2	2 conductor, 18 awg, non shielded	9740 / 89740	500 FT
3	6 conductor, 22 awg, shielded with drain	8777 / 82777	500 FT
4	Category 6 Network cable	7927A / 7931A	300 FT
5	4 conductor (2 PAIR), 22 awg, individually shielded with drain	8723 / 82723	2000 FT

NOTES:

- COORDINATE LOCKING HARDWARE WITH SECURITY. LOCKS BY DOOR HARDWARE
- DETAILS ARE FOR REFERENCE ONLY. SEE PLANS FOR SWING, DEVICE PLACEMENT, ETC
- FRAME MODIFICATIONS ARE BY DOOR HARDWARE
- ALL CONDUIT, FITTINGS, BACK BOXES ETC. BY ELECTRICAL
- ALL MAGLOCK CONNECTIONS MUST BE IN CONDUIT
- DOOR CONTACTS REQUIRE 1" HOLE IN FRAMES AND DOORS PREPPED BY DOOR HARDWARE FOR 1076 CONTACT
- SUPPLY AND INSTALL FIRE HANDPULL STATION C/W AUXILIARY CONTACT TO DIRECTLY RELEASE MAGNETIC LOCK IN ACCORDANCE WITH O.B.C. SECTION 3.4.6.15
- PROVIDE EMERGENCY POWER LIGHTING IN CONFORMANCE WITH O.B.C. 3.4.6.15(4)(k) AND ARTICLE 3.2.7.3 AT DOOR(S) EQUIPPED WITH MAGLOCKS.
- OBTAIN AND PROVIDE SECURITY CONTRACTOR WITH VERIFICATION OF THE PULL STATION BY AN APPROVED 3RD PARTY INCLUDING, CERTIFICATES CAN/ULC-S524-M91 FROM CABLE CONTRACTOR AND CAN/ULC-S537-97 FROM LIFE SAFETY COMPANY INSTALLER AND SCHEDULE THE REQUIRED TESTS WITH SECURITY CONTRACTOR SO THAT THE MAGLOCKS CAN BE VERIFIED AT THE SAME TIME.



Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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CONSULTANT

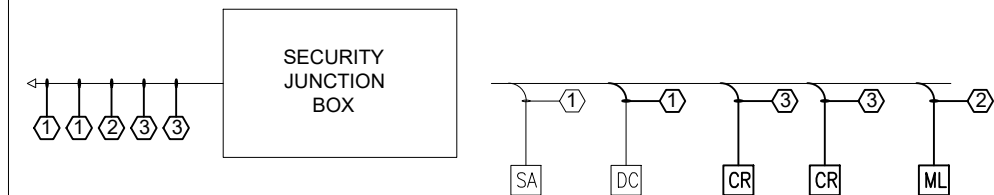
Disclaimer

PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

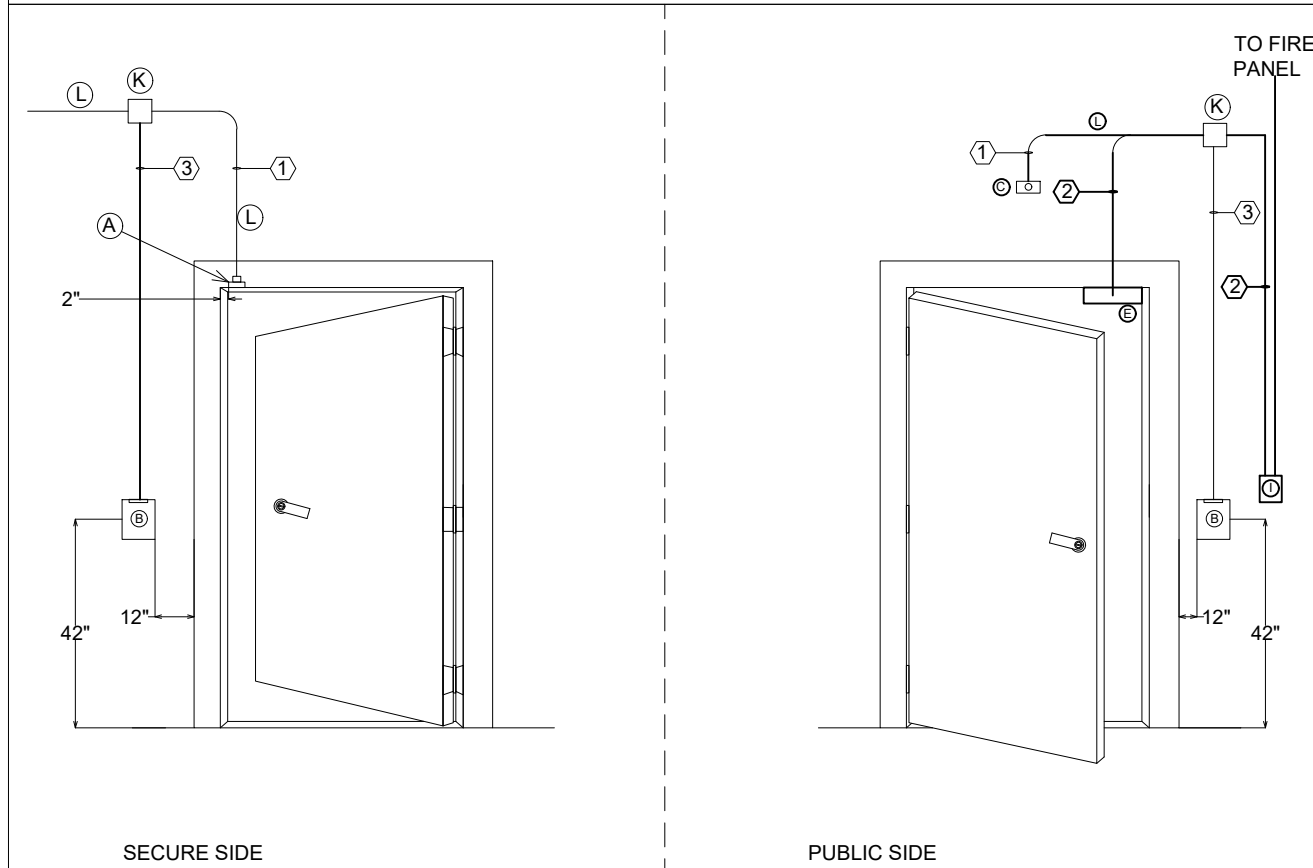
TITLE: Security Device Library
Infrastructure Devices
TYPE WRK (Wall Rack)

Date: 26MAR19 Scale: NTS Project #:

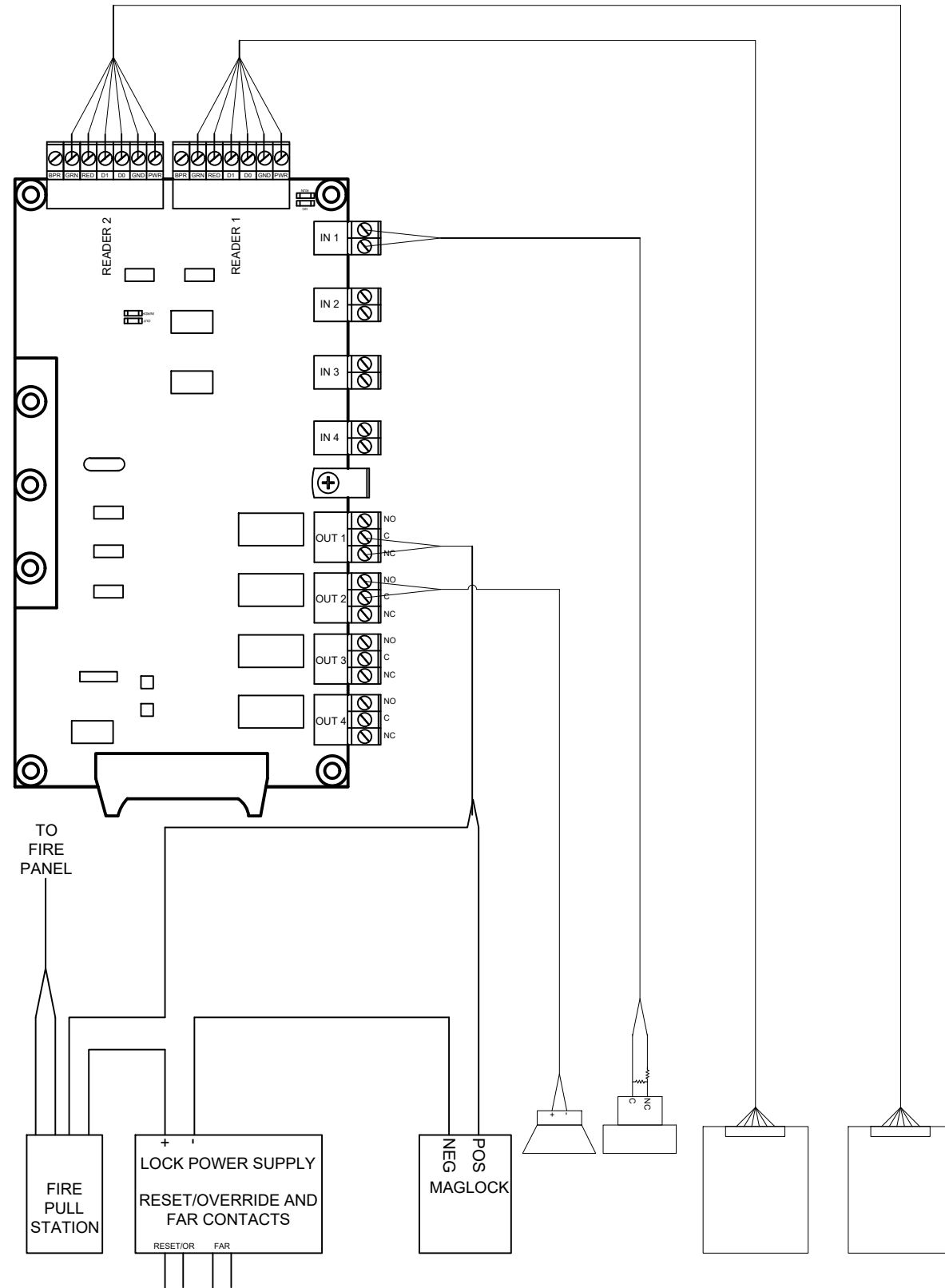
Drawing # : 2019-COB-TYP-WRK



ALL CABLES TO ACCESS CONTROL PANEL BY SECURITY CONTRACTOR. CONDUIT BY ELECTRICAL, TO APPROPRIATE CABLE TRAY OR NEAREST PANEL AS REQUIRED



<p>Device Legend</p> <ul style="list-style-type: none"> (A) DOOR CONTACT (B) CARD READER (C) LOCAL AUDIBLE (D) DOOR STRIKE (E) ELECTROMAGNETIC LOCK (F) REQUEST TO EXIT MOTION DETECTOR (G) EXIT BUTTON (H) ELECTRIFIED HINGE (I) ELECTRONIC LOCKSET (REX) 	<ul style="list-style-type: none"> (J) 4" X 4" JUNCTION BOX (K) 3/4" CONDUIT (MINIMUM) FROM JUNCTION BOX TO CONTROL EQUIPMENT (L) LATCH GUARD (M) DOOR OPERATOR (N) DOOR OPERATOR INTERFACE NETWORK (O) INTERCOM (P) BIOMETRIC READER 	<ul style="list-style-type: none"> (Q) STOREROOM LOCKSET - NON ELECTRONIC (R) 4" X 4" JUNCTION BOX (S) 3/4" CONDUIT (MINIMUM) FROM JUNCTION BOX TO CONTROL EQUIPMENT (T) LATCH GUARD (U) DOOR OPERATOR (V) DOOR OPERATOR INTERFACE NETWORK (W) INTERCOM (X) BIOMETRIC READER
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CABLE IDENTIFICATION

Type	Description	Reference # FT4/FT6	Max Length
1	4 conductor, 22 awg, non shielded	8444 / 88444	500 FT
2	2 conductor, 18 awg, non shielded	9740 / 89740	500 FT
3	6 conductor, 22 awg, shielded with drain	8777 / 82777	500 FT
4	Category 6 Network cable	7927A / 7931A	300 FT
5	4 conductor (2 PAIR), 22 awg, individually shielded with drain	8723 / 82723	2000 FT

- NOTES:**
- COORDINATE LOCKING HARDWARE WITH SECURITY. LOCKS BY DOOR HARDWARE
 - DETAILS ARE FOR REFERENCE ONLY. SEE PLANS FOR SWING, DEVICE PLACEMENT, ETC
 - FRAME MODIFICATIONS ARE BY DOOR HARDWARE
 - ALL CONDUIT, FITTINGS, BACK BOXES ETC. BY ELECTRICAL
 - ALL MAGLOCK CONNECTIONS MUST BE IN CONDUIT
 - DOOR CONTACTS REQUIRE 1" HOLE IN FRAMES AND DOORS PREPPED BY DOOR HARDWARE FOR 1076 CONTACT
 - SUPPLY AND INSTALL FIRE HANDPULL STATION C/W AUXILIARY CONTACT TO DIRECTLY RELEASE MAGNETIC LOCK IN ACCORDANCE WITH O.B.C. SECTION 3.4.6.15
 - OBTAIN AND PROVIDE SECURITY CONTRACTOR WITH VERIFICATION OF THE PULL STATION BY AN APPROVED 3RD PARTY INCLUDING, CERTIFICATES CAN/ULC-S524-M91 FROM CABLE CONTRACTOR AND CAN/ULC-S537-97 FROM LIFE SAFETY COMPANY INSTALLER AND SCHEDULE THE REQUIRED TESTS WITH SECURITY CONTRACTOR SO THAT THE MAGLOCKS CAN BE VERIFIED AT THE SAME TIME.
 - PROVIDE EMERGENCY POWER LIGHTING IN CONFORMANCE WITH O.B.C. 3.4.6.15(4)(k) AND ARTICLE 3.2.7.3 AT DOOR(S) EQUIPPED WITH MAGLOCKS.



Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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CONSULTANT

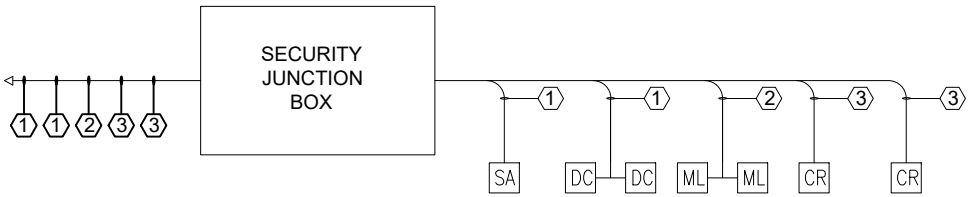
Disclaimer

PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

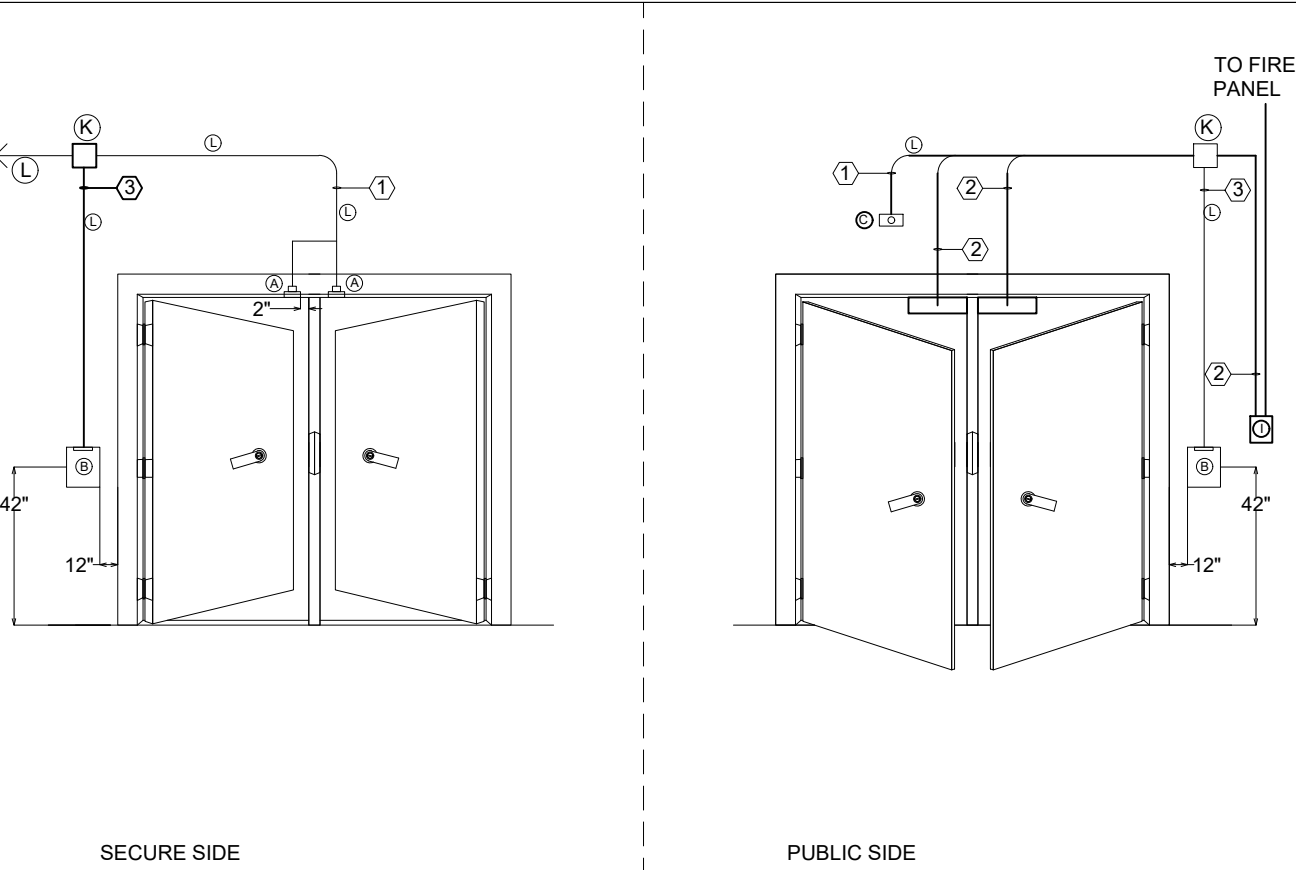
TITLE: Security Device Library
Infrastructure Devices
TYPE WRK (Wall Rack)

Date: 26MAR19	Scale: NTS	Project #:
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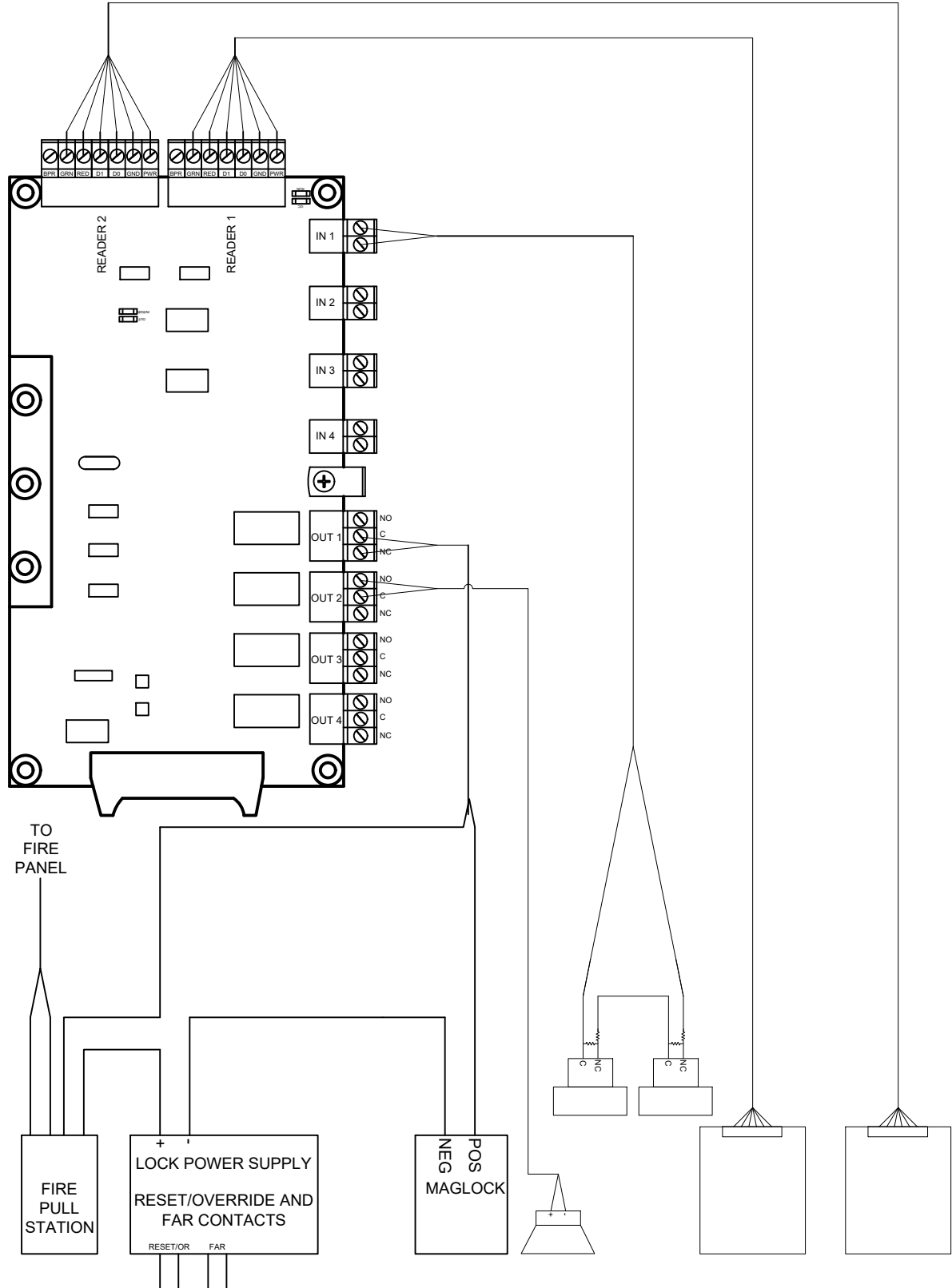
Drawing # : 2019-COB-TYP-WRK



ALL CABLES TO ACCESS CONTROL PANEL BY SECURITY CONTRACTOR. CONDUIT BY ELECTRICAL, TO APPROPRIATE CABLE TRAY OR NEAREST PANEL AS REQUIRED



- Device Legend**
- | | | | |
|-------------------------------------|------|---|------|
| (A) DOOR CONTACT | [DC] | (L) STOREROOM LOCKSET - NON ELECTRONIC | [LB] |
| (B) CARD READER | [CR] | (K) 4" X 4" JUNCTION BOX | [K] |
| (C) LOCAL AUDIBLE | [SA] | (L) 3/4" CONDUIT (MINIMUM) FROM JUNCTION BOX TO CONTROL EQUIPMENT | [L] |
| (D) DOOR STRIKE | [ES] | (M) LATCH GUARD | [M] |
| (E) ELECTROMAGNETIC LOCK | [ML] | (N) DOOR OPERATOR | [N] |
| (F) REQUEST TO EXIT MOTION DETECTOR | [RM] | (O) DOOR OPERATOR INTERFACE NETWORK | [O] |
| (G) EXIT BUTTON | [EB] | (P) INTERCOM | [P] |
| (H) ELECTRIFIED HINGE | [TH] | (Q) BIOMETRIC READER | [Q] |
| (I) ELECTRONIC LOCKSET (REX) | [EL] | | |

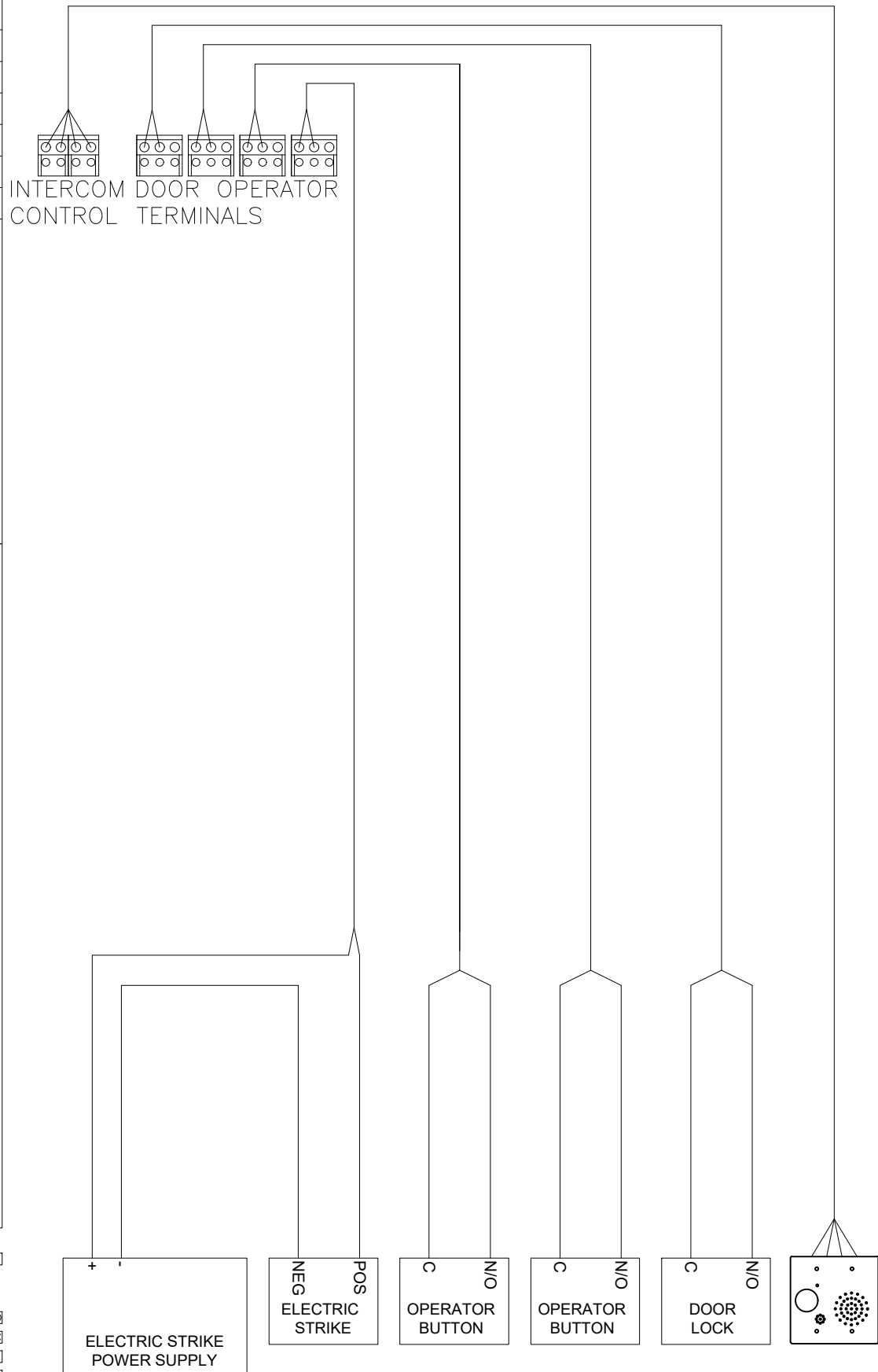


CABLE IDENTIFICATION

Type	Description	Reference # FT4/FT6	Max Length
1	4 conductor, 22 awg, non shielded	8444 / 88444	500 FT
2	2 conductor, 18 awg, non shielded	9740 / 89740	500 FT
3	6 conductor, 22 awg, shielded with drain	8777 / 82777	500 FT
4	Category 6 Network cable	7927A / 7931A	300 FT
5	4 conductor (2 PAIR), 22 awg, individually shielded with drain	8723 / 82723	2000 FT

NOTES:

1. COORDINATE LOCKING HARDWARE WITH SECURITY. LOCKS BY DOOR HARDWARE
2. DETAILS ARE FOR REFERENCE ONLY. SEE PLANS FOR SWING, DEVICE PLACEMENT, ETC
3. FRAME MODIFICATIONS ARE BY DOOR HARDWARE
4. ALL CONDUIT, FITTINGS, BACK BOXES ETC. BY ELECTRICAL
5. DOOR CONTACTS REQUIRE 1" HOLE IN FRAMES AND DOORS PREPPED BY DOOR HARDWARE FOR 1076 CONTACT



Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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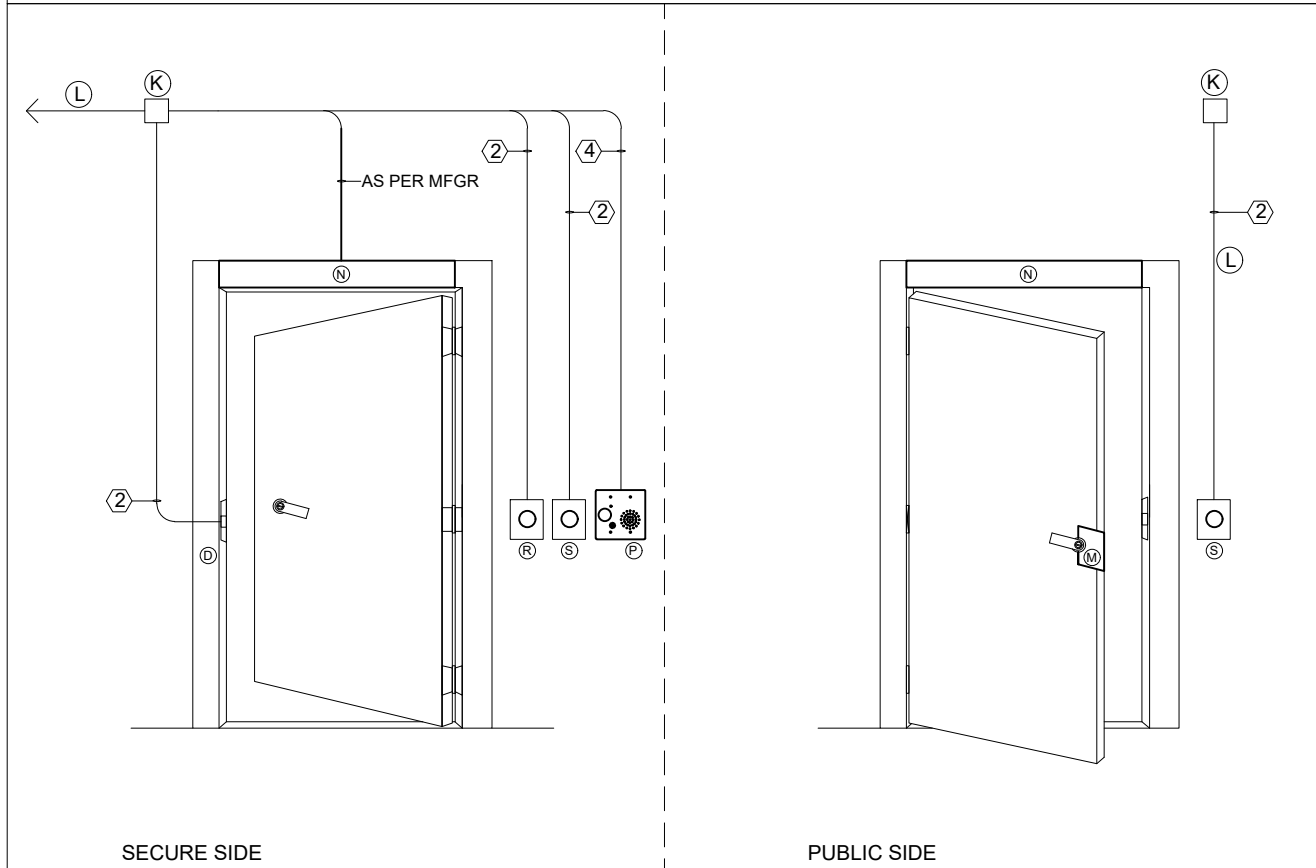
PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

TITLE: Security Device Library
Communications Devices
Washroom Intercom

Date: 26MAR19	Scale: NTS	Project #:
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Drawing # : 2019-COB-TYP-I01

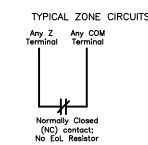
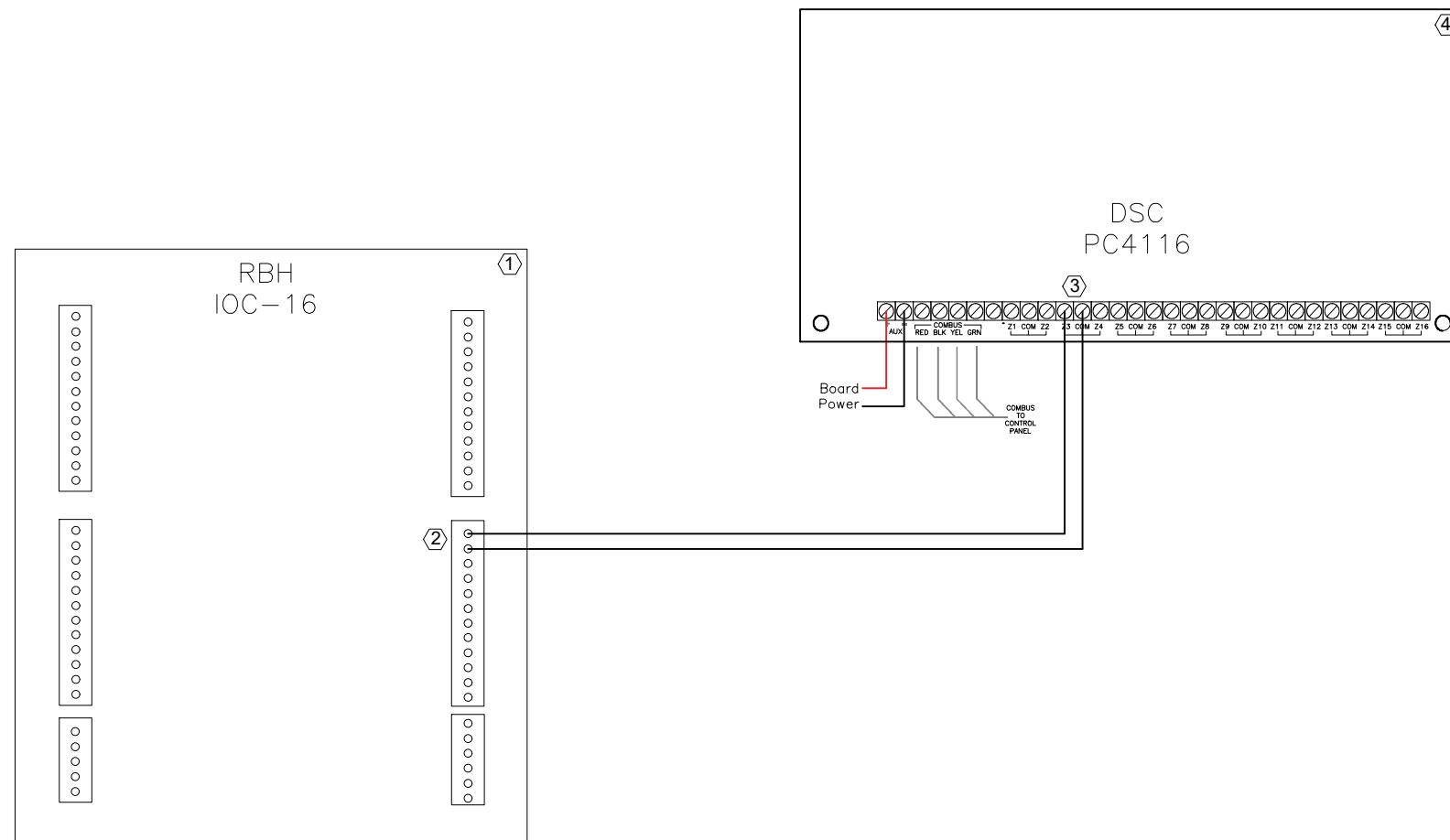
ALL CABLES TO CONTROL EQUIPMENT BY SECURITY CONTRACTOR. CONDUIT BY ELECTRICAL, TO APPROPRIATE CABLE TRAY OR NEAREST PANEL AS REQUIRED.



Device Legend (A) DOOR CONTACT (B) CARD READER (C) LOCAL AUDIBLE (D) DOOR STRIKE (E) ELECTROMAGNETIC LOCK (F) REQUEST TO EXIT MOTION DETECTOR (H) ELECTRIFIED HINGE (I) ELECTRONIC LOCKSET (REX)	(J) STOREROOM LOCKSET - NON ELECTRONIC (K) 4" X 4" JUNCTION BOX (L) 3/4" CONDUIT (MINIMUM) FROM JUNCTION BOX TO CONTROL EQUIPMENT (M) LATCH GUARD (N) DOOR OPERATOR (O) DOOR OPERATOR INTERFACE NETWORK (P) INTERCOM (R) BIOMETRIC READER (S) WASHROOM LOCK BUTTON (T) DOOR OPERATOR BUTTON
---	--

LEGEND

	Description
1	RBH IOC-16 Input/Output Board
2	RBH IOC-16 OUTPUT, Configured NOrmally Closed
3	DSC ZONE INPUT
4	DSC PC4116, 16 Zone Input Expansion Module



Theory of Operation:

The RBH Axiom system allows for output activation based on user definable conditions including, but not limited to, Access Controlled door alarms, input activation, and faults. When the output (2) on the I/O board (1) is activated it changes state. This state change is detected by the intrusion system's zone input (3). The intrusion system treats this as any other zone activation and acts accordingly. This zone can be configured as a 24hr zone or a zone that can be bypassed.

Scenario:

Output (2) is programmed to activate when any access control door experiences a Door Held event. The zone input(3) is part of a area that can be armed/disarmed during normal operations. This allows for a door to be propped open during the day without an alarm transmission.



Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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PROJECT: City of Brampton
22 Wellington St. West
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L6Y 4R2

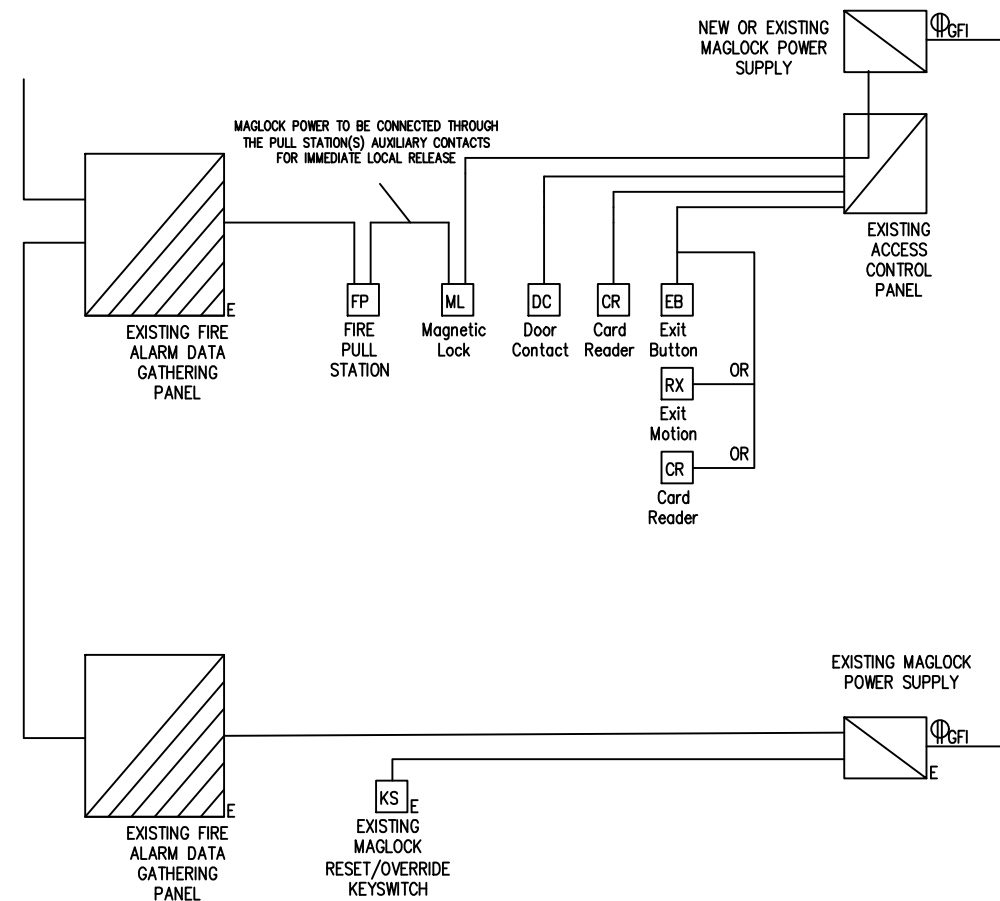
TITLE: Security Device Library
Technical Concept
RBH-DSC Interface

Date: 26MAR19	Scale: NTS	Project #:
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Drawing # : 2019-COB-TYP-TO1

MAGLOCK INSTALLATION NOTES

1. PROVIDE ALL PROVISIONS IN CONFORMANCE WITH THE ONTARIO FIRE CODE 2.72 "EXIT DOOR HARDWARE" AND ONTARIO BUILDING CODE 3.4.6.15
2. MAGLOCKS SHALL RELEASE IMMEDIATELY UPON LOSS OF POWER TO THE FIRE ALARM PANEL OR LOSS OF POWER TO THE MAGLOCK POWER SUPPLY
3. MAGLOCKS SHALL RELEASE IMMEDIATELY UPON DETECTION OF A FAULT BETWEEN THE FIRE ALARM CONTROL PANEL AND THE MAGLOCK CONTROLLER
4. A LEGIBLE SIGN CONTAINING THE WORDS "EMERGENCY EXIT UNLOCKED BY FIRE ALARM" SHALL BE PERMANENTLY MOUNTED ON THE DOORS CONTROLLED BY THE NEW MAGLOCKS. THE LETTERING SHALL BE AT LEAST 25mm HIGH WITH A 5mm STRIKE. THE SIGN SHALL BE WHITE WITH RED LETTERING.
5. UPON RELEASE, THE MAGLOCKS MUST BE RESET MANUALLY BY THE ACTUATION OF THE "MANUAL RELEASE CONTROL SWITCH" AT THE FIRE DEPARTMENT ENTRANCE OR IN THE 24/7 SECURITY OR LIFE SAFETY OFFICE
6. PROVIDE 10 LUX OF ILLUMINATION, TIED INTO EMERGENCY LIGHTING, AT THE DOOR THRESHOLD



TYPICAL MAGLOCK
INSTALLATION DETAILS
N.T.S.



Revision History

Rev.	Date:	By:	Details:
1.0	26MAR19	NA	Issued for Review

Drawn By: ZB1	Approved By: SB	Revision#: 1.0
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CONSULTANT

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PROJECT: City of Brampton
22 Wellington St. West
Brampton, Ontario
L6Y 4R2

TITLE: Security Device Library
Technical Concept
Electromagnetic Lock Interconnect

Date: 26MAR19	Scale: NTS	Project #:
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Drawing # : 2019-COB-TYP-TO2

1. General

1.1 SUMMARY

- .1 The project is pursuing LEED v4 BD+C: New Construction Gold Certification and Zero Carbon Building (ZCB) Design v3 certification. The Contractor, sub-contractors, suppliers and manufacturers are required to participate as indicated to achieve LEED Gold Certification and ZCB Design certification.

1.2 LEED REQUIREMENTS

- .1 Sub-contractors shall fully understand the project's LEED v4 BD+C requirements as listed in the following sections:
- .1 01 35 18 A LEED Scorecard
 - .2 01 57 13 Erosion and Sedimentation Control
 - .3 01 60 13 LEED Product Requirements
 - .4 01 60 13 A LEED Material Submittal Form
 - .5 01 60 13 B LEED Emissions Submittal Form
 - .6 01 74 19 Construction Waste Management
 - .7 01 81 19 Indoor Air Quality Management

1.3 REFERENCES

- .1 US Green Building Council. LEED Reference Guide, USGBC LEED v4 BD+C:
<https://www.usgbc.org/credits?Version=%22v4%22&Rating+System=%22New+Construction%22>

2. Products

2.1 MATERIALS

- .1 Not Used.

3. Execution

3.1 INSTALLATION

- .1 Not used.

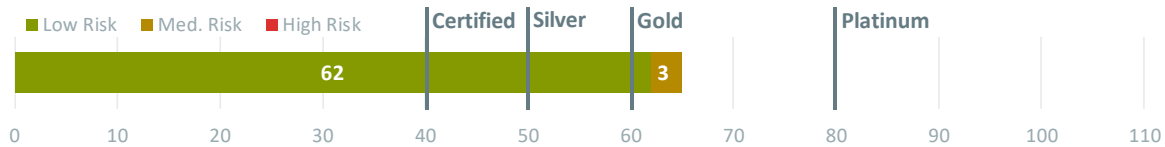
3.2 SHOP DRAWING SUBMISSION AND REVIEW

- .1 Sub-trades shall refer to 01 60 13 LEED Product Requirements. Ensure that each shop drawing submission is submitted along with completed LEED Material Submittal Forms, LEED Emissions Submittal Forms, and supporting documents as applicable.
- .2 Shop drawings of equipment with refrigerants should note refrigerant type, charge, cooling capacity and equipment life.
- .3 Shop drawings for energy-related equipment shall note efficiency parameters.

- .4 Shop drawings of electric vehicle supply equipment (EVSE) shall demonstrate compliance with the following:
 - .1 Provide a Level 2 charging capacity (208 – 240 volts) or greater.
 - .2 Comply with the relevant regional or local standard for electrical connectors, such as SAE Surface Vehicle Recommended Practice J1772, SAE Electric Vehicle Conductive Charge Coupler or IEC 62196 of the International Electrotechnical Commission.
 - .3 Meet the connected functionality criteria for ENERGY STAR certified EVSE and be capable of responding to time-of-use market signals (e.g. price).
- .5 Shop drawings of energy sub-meters shall demonstrate compliance with the following:
 - .1 Meters must be permanently installed, record at intervals of one hour or less, and transmit data to a remote location.
 - .2 Electricity meters must record both consumption and demand. Whole-building electricity meters shall record the power factor, if appropriate.
 - .3 The data collection system must use a local area network, building automation system, wireless network, or comparable communication infrastructure.
 - .4 The system must be capable of storing all meter data for at least 36 months.
 - .5 The data must be remotely accessible.
 - .6 All meters in the system must be capable of reporting hourly, daily, monthly, and annual energy use.
- .6 Shop drawings for wall, ceiling and flooring shall be provided with the following:
 - .1 Wall type tag (W1, W2, etc.) matching the architectural drawings.
 - .2 Total surface area to be installed on site (m² or ft²).
 - .3 Manufacturer's cutsheets or letters identifying surface reflectance values, typically expressed as a fraction or percentage LR (light reflectance) or LRV (light reflectance value). If manufacturers' data do not include reflectance, the contractor and/or subcontractor shall measure the reflectance of product samples (before construction) or the installed product (post-construction) using the methodology described in IES Lighting Handbook, Section 9.12.2, Measuring Reflectance and Transmittance. Or use reflectance charts, such as Lighting Guide 11, Surface Reflectance and Colour.
- .7 Shop drawings of lighting should note the following:
 - .1 Luminance between 45 and 90 degrees (candela / m²) or Unified Glare Rating;
 - .2 CRI value (≥ 90); and
 - .3 mercury content (mg), Mean Light Output per Bulb Types (lumens), and rated Life per Bulb.

End of Section

1. LEED v4 BD+C: New Construction Scorecard



Integrative Process				Renewable Energy (v4.1)			
	Tqtd.	Risk		Tqtd.	Risk		
IPc1	Integrative Process	1/1	1	EAc6	Renewable Energy (v4.1)	5/5	5
				EAc7	Enhanced Refrigerant Mgmt.	1/1	1
Location & Transportation				Materials & Resources			
ND	LEED-Neighborhood	0/16		MRp1	Collection of Recyclables	P	P
LTc1	Sensitive Land Protection	1/1	1	MRp2	Construction Waste Mgmt.	P	P
LTc2	High Priority Site	0/2		MRC1	Bldg Life-Cycle Impact Reduction	1/5	1
LTc3	Density and Diverse Uses (v4.1)	1/5	1	MRC2	Enviro. Product Declarations (v4.1)	1/2	1
LTc4	Access to Quality Transit	0/5		MRC3	Sourcing of Raw Materials (v4.1)	2/2	1 1
LTc5	Bicycle Facilities	1/1	1	MRC4	Material Ingredients (v4.1)	1/2	1
LTc6	Reduced Parking Footprint (4.1)	0/1		MRC9	Construction Waste Mgmt.	2/2	2
LTc7	Electric Vehicles (v4.1)	1/1	1				
Sustainable Sites				Indoor Environ. Quality			
SSp1	Construction Pollution	P	P	EQp1	Min Indoor Air Quality	P	P
SSc1	Site Assessment	0/1		EQp2	Tobacco Smoke Control	P	P
SSc2	Protect/Restore Habitat	0/2		EQc1	Enhanced Indoor Air Quality	2/2	2
SSc3	Open Space	0/1		EQc2	Low-Emitting Materials (v4.1)	3/3	3
SSc4	Rainwater Mgmt. (v4.1)	0/3		EQc3	Construction IAQ Plan	1/1	1
SSc5	Heat Island Reduction	0/2		EQc4	Indoor Air Quality Assessment	2/2	1 1
SSc6	Light Pollution Reduction	1/1	1	EQc5	Thermal Comfort	1/1	1
				EQc6	Interior Lighting (v4.1)	1/2	1
				EQc7	Daylight (v4.1)	1/3	1
				EQc8	Quality Views	1/1	1
				EQc9	Acoustic Performance	0/1	
Water Efficiency				Innovation			
WEp1	Outdoor Water Use	P	P	INc1	Low Mercury Lamps	1/1	1
WEp2	Indoor Water Use	P	P	INc2	Green Building Education	1/1	1
WEp3	Bldg-Level Water Metering	P	P	INc3	EAc6 Exemplary	1/1	1
WEc1	Outdoor Water Use	2/2	2	INc4	Local Food Production (v4.1)	1/1	1
WEc2	Indoor Water Use	2/6	2	INc5	All Gender Restrooms	1/1	1
WEc3	Cooling Tower Water Use	0/2		INc6	LEED AP BD+C	1/1	1
WEc4	Water Metering	1/1	1				
Energy & Atmosphere				Regional Priority			
EAp1	Fundamental Cx	P	P	RPC1	EAc2 (10 pts.)	1/1	1
EAp2	Min. Energy	P	P	RPC2	SSc5 (2 pts.)	0/1	
EAp3	Bldg-Level Energy Metering	P	P	RPC3	SSc4 (2 pts.)	0/1	
EAp4	Refrigerant Mgmt.	P	P	RPC4	MRC1 (3 pts.)	0/1	
EAc1	Enhanced Cx	3/6	3				
EAc2	Optimize Energy	18/18	18				
EAc3	Advanced Energy Metering	1/1	1				
EAc4	Demand Response	0/2					

Note that the LEED scorecard is a living document and will be updated throughout the project.

End of Section

1. General

1.1 SUMMARY

- .1 The Contractor and sub-contractors shall select sustainable and healthy building materials in accordance with LEED v4.1 BD+C requirements and achieve at least three LEED points in Building Product Disclosure and Optimization credits (Environmental Product Declarations, Sourcing of Raw Materials and Material Ingredients) and three points in Low Emitting Materials credit.
- .2 This section describes LEED v4.1 BD+C requirements for construction product and material selection and shop drawing review processes.
- .3 Sub-contractors shall provide completed LEED Material Submittal Forms and LEED Emissions Submittal Forms for all relevant products and materials when submitting shop drawings for review.

1.2 LEED REQUIREMENTS

- .1 Refer to Section 01 35 18 for LEED Requirements.

1.3 REFERENCES

- .1 US Green Building Council. LEED Reference Guide, USGBC LEED v4.1 BD+C: <https://www.usgbc.org/credits/?Version=%22v4.1%22&Rating+System=Schools+-+New+Construction&Category=Indoor+environmental+quality>
 - .1 Indoor Environmental Quality Credit 1: Low Emitting Materials.
 - .2 Materials and Resources Credit 2: Building Product Disclosure and Optimization - Environmental Product Declarations.
 - .3 Materials and Resources Credit 3: Building Product Disclosure and Optimization - Sourcing of Raw Materials.
 - .4 Materials and Resources Credit 4: Building Product Disclosure and Optimization – Material Ingredients.
- .2 CDPH Standard Method v1.2-2017: California Department of Public Health (CDPH) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers.
- .3 The Canadian VOC Concentration Limits for Architectural Coatings.
- .4 California Air Resources Board (CARB) 2007 Suggested Control Measure (SCM) for Architectural Coatings.
- .5 ASTM D 5456 (for structural composite lumber).
- .6 ANSI A190.1 (for glued laminated timber).
- .7 ASTM D 5055 (for I-joists), ANSI PRG 320 (for cross-laminated timber).
- .8 PS 20-15 (for finger-jointed lumber).

- .9 SCAQMD – South Coast Air Quality Management District.
 - .1 Rule 1113: Architectural Coatings (amended February 5, 2016, effective date 1/1/19).
 - .2 Rule 1168: Adhesive and Sealant Applications (amended October 6, 2017).

1.4

DEFINITION

- .1 Bio-Based Material: commercial or industrial products (other than food or feed) that are composed in whole, or in significant part, of biological products, renewable agricultural materials (including plant, animal, and marine materials), or forestry materials. For the purposes of LEED, this excludes leather and other animal hides.
- .2 Building Exterior: a structure’s primary and secondary weatherproofing system, including waterproofing membranes and air- and water-resistant barrier materials, and all building elements outside that system
- .3 Building Interior: everything inside a structure’s weatherproofing membrane.
- .4 Chain of Custody (CoC): a procedure that tracks a product from the point of harvest or extraction to its end use, including all successive stages of processing, transformation, manufacturing, and distribution.
- .5 Cradle-to-Gate Assessment: analysis of a product’s partial life cycle, from resource extraction (cradle) to the factory gate (before it is transported for distribution and sale). It omits the use and the disposal phases of the product.
- .6 Composite Wood: all particleboard, medium density fiberboard (both medium density and thin), hardwood plywood with veneer, composite or combination core, and wood structural panels or structural wood products.
- .7 Environmental Product Declaration (EPD): a statement that the item meets the environmental requirements of ISO 14021–1999, ISO 14025–2006 and EN 15804, or ISO 21930–2007.
- .8 Extended Producer Responsibility: measures undertaken by the maker of a product to accept its own and sometimes other manufacturers’ products as postconsumer waste at the end of the products’ useful life. Producers recover and recycle the materials for use in new products of the same type. To count toward credit compliance, a program must be widely available. For carpet, extended producer responsibility must be consistent with NSF/ANSI 140–2007. Also known as closed-loop program or product take-back.
- .9 Interior Floor Finish: all the layers applied over a finished subfloor or stairs, including stair treads and risers, ramps, and other walking surfaces. Interior finish excludes building structural members, such as beams, trusses, studs, or subfloors, or similar items. Interior finish also excludes nonfull spread wet coatings or adhesives.

- .10 Interior Wall and Ceiling Finish: all the layers comprising the exposed interior surfaces of buildings, including fixed walls, fixed partitions, columns, exposed ceilings, and interior wainscoting, paneling, interior trim or other finish applied mechanically or for decoration, acoustical correction, surface fire resistance, or similar purposes.
- .11 Life-Cycle Assessment: an evaluation of the environmental effects of a product from cradle to grave, as defined by ISO 14040–2006 and ISO 14044–2006.
- .12 Post-Consumer Recycled Content: waste generated by households or commercial, industrial and institutional facilities in their role as end users of a product that can no longer be used for its intended purpose.
- .13 Pre-Consumer Recycled Content: matter diverted from the waste stream during the manufacturing process, determined as the percentage of material, by weight. Examples include planer shavings, sawdust, bagasse, walnut shells, culls, trimmed materials, overissue publications, and obsolete inventories. The designation excludes rework, regrind, or scrap materials capable of being reclaimed within the same process that generated them (ISO 14021). Formerly known as postindustrial content.
- .14 Product (permanently installed building product): an item that arrives on the project site either as a finished element ready for installation or as a component to another item assembled on-site. The product unit is defined by the functional requirement for use in the project; this includes the physical components and services needed to serve the intended function of the permanently installed building product. In addition, similar product within a specification, each contributes as a separate product.
- .15 Raw Material: the basic substance from which products are made, such as concrete, glass, gypsum, masonry, metals, recycled materials (e.g., plastics and metals), oil (petroleum, polylactic acid), stone, agrifiber, bamboo, and wood.
- .16 Recycled Content: defined in accordance with the International Organization of Standards document ISO 14021 – Environmental labels and declarations – Self-declared environmental claims (Type II environmental labeling).
- .17 Salvaged Material: a construction component recovered from existing buildings or construction sites and reused. Common salvaged materials include structural beams and posts, flooring, doors, cabinetry, brick, and decorative items.
- .18 Wood: plant-based materials that are eligible for certification under the Forest Stewardship Council. Examples include bamboo and palm (monocots) as well as hardwoods (angiosperms) and softwoods (gymnosperms).

2. Products

2.1 MATERIALS

- .1 Not used.

3. Execution

3.1 INSTALLATION

.1 Not used.

4. LEED Product Requirements

4.1 LEED V4.1 LOW EMITTING MATERIALS

- .1 Sub-contractors shall use materials on the building interior (everything within the weatherproofing membrane) that meet LEED v4.1 low emitting criteria and meet the threshold level of compliance with emissions and VOC content standards.
- .2 Meet the following thresholds:

Table 1: Low Emitting Materials Thresholds

Category	Scope	Threshold	Requirements
Interior Paints & Coatings	All wet-applied products for architectural, mechanical and electrical work.	75% (L or m ²)	VOC Emissions Evaluation
		100%	VOC Content Requirements
Interior Adhesives & Sealants	<i>*On-site only</i>	75% (L or m ²)	VOC Emissions Evaluation
		100%	VOC Content Requirements
Flooring	All types of hard and soft surface flooring, raised flooring, wall base, underlayments, and other floor coverings. <i>Note that subflooring is included in "Composite Wood" category.</i>	90%, (\$ or m ²)	VOC Emissions Evaluation <u>OR</u> Inherently Non-Emitting <u>OR</u> Salvaged / Reused Materials
Wall Panels	All finish wall treatments (wall coverings, wall paneling, wall tile), surface wall structures such as gypsum or plaster, cubicle/curtain/partition walls, trim, interior and exterior doors, wall frames, interior and exterior windows, and window treatments.	75% (\$ or m ²)	VOC Emissions Evaluation <u>OR</u> Inherently Non-Emitting <u>OR</u> Salvaged / Reused Materials
Ceilings	All ceiling panels, ceiling tile, surface ceiling structures such as gypsum or plaster, suspended systems (including canopies and clouds), and glazed skylights.	90% (\$ or m ²)	VOC Emissions Evaluation <u>OR</u> Inherently Non-Emitting <u>OR</u> Salvaged / Reused Materials
Insulation	All thermal and acoustic boards, batts, rolls, blankets, sound attention fire blankets, foamed-in place, loose-fill, blown, and sprayed insulation. Exclude insulation for HVAC ducts and plumbing piping.	75% (\$ or m ²)	VOC Emissions Evaluation

Furniture	All seating, desks and tables, filing/storage, free-standing cabinetry, workspaces, and furnishing items purchased for the project.	75% (\$)	Furniture Emissions Evaluation <u>OR</u> Inherently Non-Emitting <u>OR</u> Salvaged / Reused Materials
Composite Wood	All wood doors, particleboard, medium density fiberboard (both medium density and thin), hardwood plywood with veneer, composite or combination core, and wood structural panels or structural wood products, and sub-flooring, built-in cabinetry.	75% (\$ or m ²)	Formaldehyde Emissions Evaluation (NAF or ULEF) <u>OR</u> Salvaged / Reused Materials

.3 VOC Emissions Evaluation

- .1 Demonstrate that products have been tested and determined compliant with California Department of Public Health (CDPH) Standard v1.2 -2017 or higher and the VOC limits in Table 4-1 of the method.
- .2 Provide a manufacturer’s documentation or 3rd party certificate showing compliance, the exposure scenarios used, and the range of total VOCs after 14 days measured as specified in CDPH Standard Method v1.2.
- .3 The state of product compliance must follow the product declaration guidelines in CDPH Standard Method v1.2-2017, Section 8. It must also include a summary report from the laboratory that is less than three years old and the amount of wet-applied product applied in mass per surface area (if applicable). Organizations that certify manufacturers’ claims must be accredited under ISO/IEC 17065.
- .4 Examples of acceptable documentation include the following:

Table 2: List of Certifications and Programs that Use CDPH Standard Method v1.2 (2017)

Certification or Program	Building Products Covered	Website
CHPS Products by Collaborative for High Performance Schools (CHPS)	Flooring, walls, ceiling, insulation, paints & coatings, adhesives, sealants & caulks	https://chps.net/products
Clean Air GOLD by Intertek	Flooring, walls, ceiling, insulation, paints & coatings, adhesives, sealants & caulks	http://www.intertek.com/certification/indoor-air-quality/
ClearChem by Berkeley Analytical	Flooring, walls, ceiling, paints & coatings, adhesives, sealants & caulks	https://clearchem.berkeleyanalytical.com/
FloorScore by SCS	Hard surface flooring materials, adhesives, and underlayment	https://www.scsglobalservices.com/services/floorscore
Green Label Plus (GLP) by CRI	Carpet, cushions and adhesives	https://carpet-rug.org/testing/green-label-plus/

GREENGUARD Gold by UL	Flooring, walls, ceiling, insulation, paints & coatings, adhesives, sealants & caulks	https://www.ul.com/resources/ul-greenguard-certification-program
Indoor Advantage Gold by SCS	Flooring, walls, ceiling, insulation, paints & coatings, adhesives, sealants & caulks	https://www.scsglobalservices.com/services/indoor-air-quality-certification
MAS Certified Green	Flooring, walls, ceiling, insulation, paints & coatings, adhesives, sealants & caulks	https://www.mascertifiedgreen.com/
NSF/ ANSI 140 Multi-attribute Certifications	Carpet	https://www.nsf.org/testing/sustainability
NSF/ ANSI 332 Multi-attribute certifications	Resilient flooring	https://www.nsf.org/testing/sustainability
VOC Green Program by Benchmark International	Flooring, walls, ceiling, insulation	https://www.benchmark-intl.com/

.4 VOC Content Evaluation

- .1 Demonstrate that the product meets the VOC content limits outlined in one of the applicable standards and methylene chloride and perchloroethylene were not intentionally added. Statement of product compliance must be made by the manufacturer or a USGBC-approved third-party. Any testing must follow the test method specified in the applicable regulation. If the applicable regulation requires subtraction of exempt compounds, any content of intentionally added exempt compounds larger than 1% weight by mass (total exempt compounds) must be disclosed.
- .2 All interior paints and coatings wet-applied on-site shall meet the following:
 - .1 California Air Resource Board (CARB) 2007 Suggested Control Measure (SCM) for Architectural Coatings
 - .2 South Coast Air Quality Management District (SCAQMD) Rule 1113, amended February 5, 2016, effective date 1/1/19
- .3 All adhesives and sealants wet-applied on-site shall meet the following:
 - .1 SCAQMD Rule 1168, October 6, 2017.

Table 3: California Resources Board (CARB) 2007

Product Type	VOC Limit
Flat coatings	50
Nonflat coatings	100
Nonflat - High gloss coatings	150
Aluminum roof coatings	400
Basement specialty coatings	400
Bituminous roof coatings	50
Bituminous roof primers	350
Bond breakers	350
Concrete curing compounds	350
Concrete/Masonry sealers	100
Driveway sealers	50
Dry-fog coatings	150
Faux finishing coatings	350
Fire resistive coatings	350
Floor coatings	100
Form-release compounds	250
Graphic arts coatings (sign paints)	500
High temperature coatings	420
Industrial maintenance coatings	250
Low solids coatings	120
Magnesite cement coatings	450
Mastic texture coatings	100

Product Type	VOC Limit
Metallic pigmented coatings	500
Multi-color coatings	250
Pre-treatment wash primers	420
Primers, sealers, and undercoaters	100
Reactive penetrating sealers	350
Recycled coatings	250
Roof coatings	50
Rust preventative coatings	250
Shellac - Clear	730
Shellac - Opaque	550
Specialty primers, sealers, and undercoaters	100
Stains	250
Stone consolidants	450
Swimming pool coatings	340
Traffic marking coatings	100
Tub and tile refinish coatings	420
Waterproofing membranes	250
Wood coatings	275
Wood preservatives	350
Zinc-rich primers	340

Table 4: SCAQMD Rule 1113 (amended February 5, 2016, effective date 1/1/19)

Product Type	VOC Limit (g/L)	Product Type	VOC Limit (g/L)
Bond breakers	350	Primers, sealers, and undercoaters	100
Colorant - Architectural coatings, excluding IM coatings	50	Reactive penetrating sealers	350
Colorant - Solvent-based IM	600	Recycled coatings	250
Colorant - Waterborne IM	50	Roof coatings	50
Concrete - Curing compounds	100	Roof coatings, aluminum	100
Concrete - Curing compounds for roadways and bridges	350	Roof primers, bituminous	350
Concrete surface retarder	50	Rust preventative coatings	100
Driveway sealer	50	Sacrificial anti-graffiti coatings	50
Dry-fog coatings	50	Shellac - Clear	730
Faux finishing coatings - Clear topcoat	100	Shellac - Pigmented	550
Faux finishing coatings - Decorative coatings	350	Specialty primers	100
Faux finishing coatings - Glazes	350	Stains	100
Faux finishing coatings - Japan	350	Stains, interior	250
Faux finishing coatings - Trowel applied coatings	50	Stone consolidants	450
Fire-proofing coatings	150	Swimming pool coatings - Repair	340
Flats	50	Swimming pool coatings - Other	340
Floor coatings	50	Tile and stone sealers	100
Form release compound	100	Traffic coatings	100
Graphic arts (sign) coatings	200	Tub and tile refinish coatings	420
Industrial maintenance coatings	100	Waterproofing sealers	100
Industrial maintenance coatings - color indicating safety coatings	480	Waterproofing concrete/masonry sealers	100
Industrial maintenance coatings - High temperature IM coatings	420	Wood coatings - varnish	275
Industrial maintenance coatings - Non-sacrificial anti-graffiti coatings	100	Wood coatings - sanding sealers	275
Industrial maintenance coatings - Zinc-rich IM primers	100	Wood coatings - lacquer	275
Magnesite cement coatings	450	Wood conditioners	100
Mastic coatings	100	Wood preservatives - Below Ground	350
Metallic pigmented coatings	150	Wood preservatives - Other	350
Multi-Color coatings	250		
Nonflat coatings	50		
Pre-treatment wash primers	420		

Table 5: SCAQMD Rule 1168 (amended October 6, 2017)

Product Type	VOC Limit	Product Type	VOC Limit
Adhesives for Architectural Applications	g/L	Specialty Applications	g/L
Building envelope membrane adhesive	250	Computer diskette manufacturing	350
Carpet pad adhesives	50	Contact adhesive	80
Ceramic glass, porcelain, & stone tile adhesive	65	Edge glue adhesive	250
Cove base adhesives	50	ABS welding cement	325
Dry wall and panel adhesives	50	ABS to PVC transition cement	510
Multi-purpose construction adhesives	70	CPVC welding cement	490
Roofing- single ply roof membrane adhesive	250	PVC welding cement	510
Roofing- all other roof adhesives	250	All other plastic cement welding cements	100
Rubber floor adhesives	60	Rubber Vulcanization Adhesive	250
Structural glazing adhesives	100	Special purpose contact adhesive	250
Structural wood member adhesive	140	Thin metal laminating adhesive	780
Subfloor adhesive	50	Tire tread adhesive	100
VCT and asphalt tile adhesives	50	Top and trim adhesive	250
Wood flooring adhesive	100	Waterproof resorcinol glue	170
All other indoor floor covering adhesives	50	All other adhesives	250
All other outdoor floor covering adhesives	50	Adhesive Primers	g/L
Substrate Specific Applications	g/L	Plastic adhesive primers	550
Metal substrate-specific adhesives	30	Pressure sensitive adhesive primers	250
Plastic foam substrate-specific adhesives	50	Traffic marking tape adhesive primers	150
Porous material (except wood) substrate-specific adhesives	50	Vehicle glass adhesive primers	250
Wood substrate-specific adhesives	30	All other adhesive primers	250
Fiberglass substrate-specific adhesives	80	Sealant Primers	g/L
Reinforced plastic composite substrate-specific adhesives	200	Architectural non-porous sealant primer	250
Sealants for Architectural Applications	g/L	Architectural porous sealant primer	775
Clear, paintable, and immediately water-resistant sealant	250	Modified bituminous sealant primer	500
Foam insulation	250	Marine deck sealant primer	760
Grout	250	All other sealant primers	750
Roadway sealant	250	Other	g/L
Non-staining plumbing putty	250	Other adhesives, adhesive bonding primers, adhesive primers, or any other primers	250
Potable water sealant	250		
Roofing - single ply roof membrane sealant	450		
Roofing - all other roof sealants	300		
All other architectural sealants	50		
Marine deck sealant	760		
All other sealants	420		

Table 6: Canadian VOC Concentration Limits for Architectural Coatings

Product Type	VOC Limit	Product Type	VOC Limit
Antenna coating	530	Any other varnish	350
Thermoplastic rubber coating and mastic	550	Low solids coating	120
Metallic pigmented coating	500	Mastic texture coating	300
Bituminous roof primer	350	Multi-coloured coating	250
Any other bituminous roof coating	300	Nuclear coating	450
Non-bituminous roof coating	250	Pre-treatment wash primer	420
Calcimine recoater	475	Specialty primer, sealer or undercoater	350
Bond breaker	350	Waterproofing sealer for concrete or masonry	400
Concrete curing compound	350	Any other waterproofing sealer	250
Concrete surface retarder	780	Any other primer, sealer or undercoater	200
Form release compound	250	Quick-dry enamel	250
Dry fog coating	400	Recycled coating	350
Extreme high durability coating	800	Rust preventive coating	400
Faux finish	350	Interior wiping stain	250
Fire resistant coating	350	Exterior wood stain, clear or semi-transparent	250
Fire retardant coating, clear	650	Any other stain, including lacquer stains	250
Fire retardant coating, opaque	350	Swimming pool coating	340
Floor enamel	250	Traffic marking coating	450
Any other opaque floor coating for application to surfaces that may be subject to foot traffic	250	Any other flat coating	100
Flow coating	650	Any other non-flat coating	150
Graphic arts coating	500	Any other high-gloss coating	250
Temperature-indicator safety coating	550		
Any other high-temperature coating	420		
Impacted immersion coating	780		
Any other industrial maintenance coating	340		
Shellac, clear	730		
Shellac, opaque	550		
Clear brushing lacquer	680		
Any other lacquer, including lacquer sanding sealers	550		
Any other sanding sealer	350		
Conversion varnish	725		
Conjugated oil varnish for sealing wood	450		

- .5 Formaldehyde Emissions Evaluation
 - .1 Demonstrate products meet one of the following:
 - .1 Certified as ultra-low-emitting formaldehyde (ULEF) product under EPA Toxic Substances Control Act, Formaldehyde Emission Standards for Composite Wood Products (TSCA, Title VI) (EPA TSCA Title VI) or California Air Resources Board (CARB) Airborne Toxic Control Measure (ATCM)
 - .2 Certified as no added formaldehyde resins (NAF) product under EPA TSCA Title VI or CARB ATCM
 - .3 Wood structural panel manufactured according to PS 1-09 or PS 2-10 (or one of the standards considered by CARB to be equivalent to PS 1 or PS 2) and labeled bond classification Exposure 1 or Exterior
 - .4 Structural wood product manufactured according to ASTM D 5456 (for structural composite lumber), ANSI A190.1 (for glued laminated timber), ASTM D 5055 (for I-joists), ANSI PRG 320 (for cross-laminated timber), or PS 20-15 (for finger-jointed lumber).
 - .2 For interior wood doors, demonstrate that products have been tested and determined compliant with California Department of Public Health (CDPH) Standard v1.2-2017 or higher, using the applicable exposure scenario. Provide a manufacturer's documentation or 3rd party certificate showing compliance and the range of total VOCs after 14 days measured as specified in CDPH Standard Method v1.2-2017.
- .6 Furniture Emissions Evaluation
 - .1 Demonstrate products have been tested in accordance with ANSI/BIFMA Standard Method M7.1–2011 (R2016) and complies with ANSI/BIFMA e3-2014e or e3-2019e Furniture Sustainability Standard, Sections 7.6.1 (for half credit, by cost) OR 7.6.2 (for full credit, by cost), OR 7.6.2 AND 7.6.3 for one and a quarter credit, by cost. Laboratories that conduct the tests must be accredited under ISO/IEC 17025 for the test methods they use.
 - .2 Seating products must be evaluated using the seating scenario. Classroom furniture must be evaluated using the standard school classroom scenario. Other products should be evaluated using the open plan or private office scenario, as appropriate. The open plan scenario is more stringent.
 - .3 Statements of product compliance must include the exposure scenario(s). Organizations that certify manufacturers' claims must be accredited under ISO/IEC 17065.

4.2 ENVIRONMENTALLY PREFERRED PRODUCTS (MR CREDITS 2,3,4)

- .1 The project shall use at least 20 different permanently installed materials from at least 5 different manufacturers that have one of the following:

- .1 Product Specific Environmental Product Declaration (EPD) Type III, conforming to ISO 14404, 14025, 21930 and/or EN 15804).
- .2 Industry Wide (Generic) Environmental Product Declaration (EPD) Type III. Manufacture must be listed by name in the EPD as a participant.
- .3 Product specific LCA that conforms to ISO 14044.
- .2 The project shall use products (at least 5 products from three different manufacturers) that have a **compliant** embodied carbon optimization report or action plan separate from the LCA or EPD. The following reporting types are acceptable:
 - .1 Embodied Carbon/LCA Action Plan.
 - .2 Reductions in Embodied Carbon: less than 10% reduction in global warming potential (GWP) relative to baseline.
 - .3 Reductions in Embodied Carbon: 10%+ reduction in GWP relative to baseline.
 - .4 Reductions in Embodied Carbon: 20%+ reduction in GWP and 5%+ reduction in two additional impact categories list below, relative to baseline.
 - .1 depletion of the stratospheric ozone layer, in kg CFC-11e;
 - .2 acidification of land and water sources, in moles H+ or kg SO₂e;
 - .3 eutrophication, in kg nitrogen equivalent or kg phosphate equivalent;
 - .4 formation of tropospheric ozone, in kg NO_x, kg O₃ eq, or kg ethene; and
 - .5 depletion of non-renewable energy resources, in MJ using CML / depletion of fossil fuels in TRACI.
- .3 The project shall use products with high recycled, FSC, materials reuse and bio-based materials content and achieve at least 25% (by cost) of the total value of the total value of permanently installed building products.
- .4 The project shall use products purchased from a manufacturer that participates in an extended producer responsibility program or is directly responsible for extended producer responsibility.
- .5 Where every possible, use products sourced (extracted, manufactured, and purchased) within 100 miles (160 km) of the project site.
- .6 The project shall use at least 20 different permanently installed products from at least five different manufacturers that use qualifying programs to demonstrate the chemical inventory of the product to at least 0.1% (1000 ppm).
- .7 Sub-contractors shall select products and materials that contributes to as many requirements listed below as possible. The product:
 - .1 Has an Environmental Product Declarations (EPDs)
 - .2 Has high recycled content or reused
 - .3 Has high FSC content (for wood products only)
 - .4 Has a Health Product Declaration (complete HPD with full disclosure of known hazards in compliance with the HPD open Standard)

- .5 Has a Cradle to Cradle Certification (Material Health Certificate or is Cradle to Cradle Certified™ under standard version 3 or later with a Material Health achievement level at the Bronze level or higher.)
- .6 Is Declare labeled
- .7 Has Product Lens Certification
- .8 Has Facts – NSF/ANSI 336: Sustainability Assessment for Commercial Furnishings Fabric
- .9 Has a Manufacturer Inventory (e.g., publicly available inventory of all ingredients identified by name and CASRN number or the Globally Harmonized System of Classification and Labeling of Chemicals rev.6 2015)
- .10 Has GreenScreen v1.2 Benchmark (fully inventoried chemical ingredients to 100 ppm that have no Benchmark 1 hazards)
- .11 Has REACH Optimization (fully inventoried chemical ingredients to 100 ppm and assess each substance against the Authorization list – Annex XIV, the Restriction list – Annex XVII and the SVHC candidate list June 2013, proving that no such substance is included in the product.)
- .12 Is purchased from manufacturers that participates in an extended producer responsibility program or is directly responsible for extended producer responsibility.
- .13 Meet the Sustainable Agriculture Network’s Sustainable Agriculture Standard (for bio-based materials only)
- .14 Has a Living Product Challenge label
- .15 Is 100% regionally extracted, manufactured, and purchased within 160 km of the project site.

5. Shop Drawing Submission

5.1 LEED FORMS AND SUPPORTING DOCUMENTS

- .1 Sub-contractors shall include all of the following when submitting shop drawings for review. Identify all relevant products that will be supplied / used. All products and materials shall be reviewed by the LEED consultant before they are purchased.
 - .1 Fully completed LEED Material Forms (01 60 13A) for all products. (i.e. HVAC shop drawing must include all associated adhesives, sealants, insulation, coatings, etc.)
 - .2 Fully completed LEED Emission Forms (01 60 13B) for all of the following: paints, coatings, adhesives, sealants, flooring (including sub-flooring), composite wood (including built-in cabinetry), any architectural woodwork, ceilings, walls (including doors, partial-height vertical surfaces, and interior columns), thermal and acoustic insulation, roofing, and weatherproofing.
 - .3 Supporting documentation demonstrating compliance with LEED credits.

End of Section

1. General

1.1 SUMMARY

- .1 The Contractor and sub-contractors shall minimize airborne contaminants and implement indoor air quality (IAQ) measures and comply with the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 2nd edition, 2007, ANSI/SMACNA 008-2008, Chapter 3 to protect the health and safety of construction personnel and future occupants.
- .2 The Contractor and sub-contractors shall comply with indoor air quality requirements throughout construction described in this section and in the project's Indoor Air Quality Management Plan.
- .3 The Contractor and sub-contractors shall achieve Indoor Environmental Quality Credit 3: Construction Indoor Air Quality Management Plan and Indoor Environmental Quality Credit 4: Indoor Air Quality Assessment (Option 1 Flush-Out).

1.2 LEED REQUIREMENTS

- .1 Refer to Section 01 35 18 for LEED Requirements.
- .2 Refer to Section 01 61 13 **LEED Product Requirements**: Indoor Environmental Quality Credit 2: Low Emitting Materials requirements.

1.3 REFERENCES

- .1 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA): IAQ Guidelines for Occupied Buildings Under Construction. 2nd edition, 2007, ANSI/SMACNA 008-2008, Chapter 3.
- .2 US Green Building Council. LEED Reference Guide: USGBC LEED v4 BD+C:
<https://www.usgbc.org/credits?Version=%22v4%22&Rating+System=%22New+Construction%22&Category=%22Indoor+environmental+quality%22>
 - .1 Indoor Environmental Quality Credit 3: Construction Indoor Air Quality Management Plan.
 - .2 Indoor Environmental Quality Credit 4: Indoor Air Quality Assessment.

2. Products

2.1 MATERIALS

- .1 Not used.

3. Execution

3.1 PLAN DEVELOPMENT

- .1 The Contractor shall develop the Indoor Air Quality Management Plan.

- .2 The plan shall address responsibilities of Contractor and sub-contractors, project goals, inspection and reporting requirements and detailed requirements of LEED v4 BD+C: Schools Indoor Environmental Quality 3 Construction Indoor Air Quality Management Plan and IEQc4 Indoor Air Quality Assessment.

3.2 IMPLEMENTATION OF IAQ PLAN

- .1 The Contractor shall ensure that the project's IAQ Management Plan is introduced to new trades during training sessions and is always available to all sub-contractors.
- .2 The Contractor shall distribute the plan to all relevant sub-contractors and post it in an accessible location on site.
- .3 The Contractor shall discuss IAQ management at meetings which include sub-contractors impacted by the IAQ Management Plan. (i.e. pre-construction meeting, regular job-site meetings, etc.)

3.3 INSPECTION AND REPORTING

- .1 The Contractor or a designated sub-contractor shall monitor the condition of all IAQ measures on site and take photos of all relevant IAQ measures, deficiencies, and/or corrective actions taken at least weekly.
- .2 The Contractor or a designated sub-contractor shall complete an IAQ Inspection Log weekly and provide log and photographs to the LEED Consultant at least monthly. Any deficiency identified during inspections must be documented in the log and relevant sub-contractors shall be notified immediately to take corrective actions. The corrective actions taken shall be documented as required in the IAQ Inspection Log.

3.4 RECORD OF FILTRATION MEDIA

- .1 Record the following as applicable:
 - .1 MERV rating of the filtration media used during construction.
 - .2 Removal and replacement dates of temporary filtration media used during construction.
 - .3 MERV rating of the filtration media installed before performing flush-out.
 - .4 Removal and replacement dates of temporary filtration media used during flush-out.
 - .5 MERV rating of filtration media installed after flush-out and before occupancy.
 - .6 Removal and replacement dates of filtration media installed after flush-out and before occupancy.

4. Indoor Air Quality Management Requirements

4.1 SCHEDULEING

- .1 Schedule construction activities to minimize or eliminate negative impacts to indoor air quality.

- .2 Testing, adjusting and balancing (TAB) and corrective work related to general deficiencies and commissioning should occur after construction completion / cleaning and before occupancy.
- .3 Schedule a building flush-out such that it will be completed prior to occupancy.
- .4 Install new filtration media (MERV 13) after construction and the flush-out and immediately before occupancy.
- .5 Before installing any absorbent materials such as ceiling tiles, carpets and fabric covered furnishings, ensure wet-applied materials have fully cured. For example:
 - .1 Install carpet and ceiling tile after paints and coatings are completely dry.
 - .2 Drywall finishing and carpet installation should be scheduled for different days or sections of the building.

4.2 HOUSEKEEPING

- .1 Remove moisture and dirt effectively and keep the indoor work areas clean.
- .2 Frequently clean work areas to remove moisture, dust and dirt throughout the day.
- .3 Immediately clean after a construction activity is completed or at the end of each day.
- .4 Complete full building clean-up on an ongoing basis, at least once a week.
- .5 Promptly clean all spills.
- .6 Use proper housekeeping tools such as: damp rags, wet mops and wet scrubber, wetting agents and sweeping compounds when sweeping, and vacuum equipped with HEPA filtration.
- .7 When needed, use ventilation/dehumidification to control humidity levels within the building.
- .8 Keep materials organized and store them in clean area (except for mechanical/electrical rooms).
- .9 Do not install materials with moisture damage or excessive moisture accumulation.

4.3 SOURCE CONTROL

- .1 Keep sources of contaminants out of the building.
- .2 Install walk-off mats at all building entryways.
- .3 Install no-smoking signs throughout the construction site.
- .4 Use electrical equipment rather than gas/oil powered equipment, where possible.

- .5 Use temporary ventilation equipment to exhaust pollutant sources directly to outside. Where this is not feasible, locally re-circulate air through a portable air cleaner.
- .6 Use proper measures to collect and bag sawdust from wood working area (e.g. dust guards and collectors).
- .7 Use low emitting construction materials fully complying with 01 06 01 LEED Product Requirements.
- .8 Use painting techniques that minimize airborne pollution (e.g., roller instead of spray).
- .9 Use proper cleaning practices and products to minimize airborne pollution wherever possible (e.g., vacuum instead of sweeping, Green Seal labeled cleaning products, etc.).
- .10 Restrict outdoor vehicular and equipment traffic and operation where emissions can enter the building.
- .11 Ensure that VOC containing products are sealed properly when not in use.
- .12 Isolate areas where high toxicity materials are used and stored. Ventilate the associated area.
- .13 Where possible, perform polluting activities (e.g. cutting) outside of the building.
- .14 Protect stored absorptive materials (e.g. gypsum board, ceiling / carpet tiles, etc.) from moisture and dust. They must be elevated (such as on a pallet), covered, and stored in clean and dry spaces away from dust generating activities.
- .15 Replace any construction materials that have moisture damage.
- .16 Do not smoke inside the building or within 7.5 m (25 ft.) of any building or HVAC openings.
- .17 Do not fuel equipment inside the building.
- .18 Do not store gasoline or solvents inside the building.
- .19 Do not burn garbage on site.
- .20 Do not use mechanical rooms for storing or collecting construction waste materials.

4.4 PATHWAY INTERRUPTION

- .1 Prevent movement of pollutants to other areas in the building.
- .2 Contain indoor polluting work areas by erecting dust curtains/barriers.
- .3 Depressurize work areas where pollution generating activities are performed.

- .4 Use portable fans to exhaust pollutants to exterior and ensure that adjacent building openings will not allow pollutants to re-enter the building.
- .5 Separate the indoor space and outdoors by installing temporary seal for exterior openings (windows, doors, HVAC openings, etc.).
- .6 Keep windows and doors closed once they are installed.
- .7 Keep completed areas separated from other areas being worked on.
- .8 Do not perform pollution generating activities in open areas with high drafts.

4.5 HVAC PROTECTION

- .1 Protect HVAC equipment throughout construction and keep them free of dust and moisture.
- .2 Cover and elevate (such as on a pallet) all stored air ducts, fittings, and other HVAC equipment before installation. Before installing, ensure that they are free of dust and moisture and perform cleaning if needed.
- .3 Seal all temporary and permanent HVAC openings (supply, return, exhaust) immediately after installation. If any seal is broken, take corrective actions immediately.
- .4 Close or cover all hatches and access doors of HVAC equipment.
- .5 Install new filters in all air handling equipment and prepare systems for testing, adjusting and balancing after final cleaning work is completed.
- .6 If permanently installed HVAC equipment must be operated during construction (not recommended), comply with the following:
 - .1 Install new filters (MERV 8 or higher) before operating any HVAC system.
 - .2 Temporary shut down of the return and exhaust side of HVAC systems during heavy construction and demolition is required. In areas with excessive dust levels, permanently close off the return and exhaust side of HVAC systems and cover openings with plastic in these areas.
 - .3 Do thorough cleaning of HVAC equipment as needed.
 - .4 After construction and final cleaning is completed, replace the filters before occupancy.
- .7 Do not remove HVAC protection measures before construction and final cleaning are completed.
- .8 Do not unwrap or remove packaging / covers until HVAC equipment is ready to be installed.
- .9 Do not operate permanently installed HVAC equipment during construction. (If this is not feasible, proper protocols must be followed as identified above.)

4.6 FLUSH-OUT PRIOR TO OCCUPANCY

- .1 General Contractor to perform a building flush-out by supplying a total air volume of 14,000 cubic feet of outdoor air per square foot (4 267 140 liters of outdoor air per square meter) of gross floor area.
 - .1 A flush-out must begin after all finishes, furniture and furnishings are installed.
 - .2 Commissioning can occur during the flush-out, provided none of the commissioning procedures introduce contaminants into the space and none of the flush-out procedures circumvent the commissioning process. Complete testing and balancing of the HVAC system after the flush-out is complete.
 - .3 New air filters (MERV 8) must be equipped before performing flush out. After completing flush-out and prior to occupancy, new air filters (MERV 13) must be installed. General Contractor to provide completed filtration media tracking sheet including:
 - .1 Date of filter installation
 - .2 Date of filter removal
 - .3 Timing of when the filter was used
 - .4 Location of the filter (e.g., equipment tag)
 - .5 MERV rating

Figure 1: Example Filtration Media Tracking Sheet

Date of Installation	Date of Removal	Ventilation Equipment (i.e. AHU-1)	MERV Rating	Timing	
2020-01-02	2020-03-01	AHU-1	8	<input checked="" type="checkbox"/>	During Construction
				<input type="checkbox"/>	After Construction and Before Flush-Out
				<input type="checkbox"/>	During Flush-Out
				<input type="checkbox"/>	After Flush-Out and Before Occupancy
2020-01-02	2020-03-01	AHU-2	8	<input checked="" type="checkbox"/>	During Construction
				<input type="checkbox"/>	After Construction and Before Flush-Out
				<input type="checkbox"/>	During Flush-Out
				<input type="checkbox"/>	After Flush-Out and Before Occupancy
2020-01-02	2020-03-01	AHU-3	8	<input checked="" type="checkbox"/>	During Construction
				<input type="checkbox"/>	After Construction and

- .1 Do not remove filtration media before the building flush-out is completed.

- .2 Monitor and maintain an internal temperature of at least 60°F (15°C) and no higher than 80°F (27°C) and relative humidity no higher than 60%. If the temperature and humidity requirements are not met, the flush-out period may be extended.
- .3 Record temperature and humidity throughout the building flush-out. Complete a daily log showing recorded temperature and humidity for each day.

Figure 2: Example Temperature & Humidity Tracking Sheet

Date	Time	Rooms / Zone	Indoor Temperatures	Indoor Relative Humidity	Is the internal temperature between 15°C and 27°C and relative humidity no higher than 60%?
2020-11-12	08:00	All	20°C	40%	Yes
2020-11-12	13:00	All	21°C	38%	Yes
2020-11-12	17:00	All	19°C	41%	Yes

- .2 General Contractor to provide a flush-out report (e.g., how the internal temperature and relative humidity was controlled, confirming the flush-out began after all finishes, furniture and furnishes were installed, etc.).

End of Section