



**REGION OF PEEL
21 DIVISION, PEEL REGIONAL POLICE FACILITY
INTERIOR RENOVATION PROJECT**

10 Peel Centre Drive, Brampton ON L6T 4B9



Tender

**PROJECT
SPECIFICATIONS
VOLUME 2 OF 2**

ISSUED FOR:

1) Issued Tender

November, 2025



Region of Peel
21 Division, Peel Regional Police Facility
Interior Renovation Project

Mechanical Specifications

Project Number:

MRK-25008049-A0

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Date Submitted:

November 14, 2025

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PART 1 - GENERAL

1.1 References

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and all Sections of Division 00 and 01 apply to and are part of this Section of the Specification.

1.2 Application

- .1 This Section specifies requirements that are common to Mechanical Divisions Work Sections and it is a supplement to each Section and is to be read accordingly. Where requirements of this Section contradict requirements of Divisions 00 or 01, conditions of Division 00 or 01 takes precedence.
- .2 Perform All Work specified herein by experienced and licensed personnel.
- .3 Be responsible for advising product vendors of requirements of this Section.

1.3 Related Work

- .1 It is the intent of these specifications to furnish and install all materials and equipment as hereinafter specified and/or as shown on the drawings in such a manner as to leave each of the systems of the mechanical trades complete and in satisfactory condition.
- .2 Where used, words "Section" and "Division" shall also include other Sub-Contractors engaged on site to perform work to make building and site complete in all respects.
- .3 Where used, word "supply" shall mean furnishing to site in location required or directed complete with accessory parts.
- .4 Where used, word "install" shall mean secured in place and connected up for operation as noted or directed.
- .5 Where used, word "provide" shall mean supply and install as each is described above.
- .6 Where used, word "delete" or "remove" (and tenses of "delete" or "remove") shall mean to disconnect, make safe, and remove obsolete materials; patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by Consultant.
- .7 Where used, word "Authorities", shall mean any agencies, standards, rules and regulations that enforces the applicable laws, ordinances, rules, regulations or code of the place of the work.
- .8 "OSHA" and "OHSA" stands for Occupational Safety and Health Administration and Occupational Health and Safety Act, and wherever either one is used, they are to be read to mean local governing occupational health and safety regulations that apply to and govern work and to which work must adhere, regardless if Project falls within either authority's jurisdiction.
- .9 Where used, word "work" shall mean all equipment, permits, materials and labour to provide a complete mechanical installation as required and detailed in the Drawings and Specifications.
- .10 Where used, words "Drawings" and "Specifications" are referred to; it means the "Contract Documents".
- .11 Where used, words "Prime Mechanical Contractor" shall mean the supervisory

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Mechanical Contractor of all Mechanical Sub-Contractors.

- .12 The term "exposed" means, within the line of sight of any person standing or sitting in the occupied space, unless defined otherwise in the following sections.
- .13 The term "concealed" means, not exposed, hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
- .14 The term "finished" means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.
- .15 The term "listed" means, that the materials or equipment are tested in accordance with applicable standards and are approved and listed for their intended use by a testing company approved by the Authorities having jurisdiction.
- .16 The term "approved", "approvals", etc., means, approved by Authorities having jurisdiction as conforming to the requirements of the Contract Documents.
- .17 The term "acceptable" or "acceptance", etc., means, acceptable to the Consultant as conforming to the requirements of the Contract Documents.
- .18 The term "submit for review" or "submit notice", etc., means, submit to the Consultant.
- .19 The term "subject to review" means, work or materials laid out for review by the Consultant. Obtain instruction from the Consultant before proceeding with the work. Submit further information, shop drawings, samples etc., as specified and/or as may be reasonably requested by the Consultant.
- .20 The term "accessible" used alone means, readily accessible by a person using tools as required without cutting or breaking out materials.
- .21 The term "noted" means, notes on the drawings, the detail drawings and on the Schedules.
- .22 "Consultant" – means person, firm or corporation identified as such in Agreement or Documents and is licensed to practice in Place of the Work, and has been appointed by Owner to act for Owner in a professional capacity in relation to the Work.
- .23 Wherever words "indicated", "shown", "noted", "listed", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to is "indicated", "shown", "listed", or "noted" on Contract Documents.
- .24 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to is "reviewed by", "to the satisfaction of", "submitted to", etc., Consultant.
- .25 The terms "instructions" or "as instructed" or "where instructed" mean as instructed by the Consultant, including supplementary instruction notices; job site instruction notices; job site instructions by a field representative/ inspector appointed by the Consultant and including all comments made regarding submittal of shop drawings and samples for review.

1.4 Documents

- .1 Documents for bidding include but are not limited to issued Drawings, Specifications and Addenda.
- .2 Drawings and Specifications are portions of Contract Documents and identify labour, products and services necessary for performance of work and form a basis for determining pricing. They are intended to be cooperative. Perform work that is shown, specified, or reasonably implied on the drawings but not mentioned in Specification, or

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- vice-versa, as though fully covered by both.
- .3 Review Drawings and Specifications in conjunction with documents of other Divisions and, where applicable, Code Consultant's report.
 - .4 Unless otherwise specifically noted in Specifications and/or on Drawings, Sections of Mechanical Divisions are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and Sections are to be read as a whole.
 - .5 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and connecting services. Any information regarding accurate measurement of building is to be taken on site. Do not scale Drawings, and do not use Drawings for prefabrication work.
 - .6 Drawings are intended to convey the scope of work and do not show architectural and structural details. Provide, at your cost, offsets, fittings, transformations and similar products required as a result of obstructions and other architectural and/or structural details but not shown on Drawings.
 - .7 Locations of equipment and materials shown may be altered, when reviewed by Consultant, to meet requirements of equipment and/or materials, other equipment or systems being installed, and of building, all at no additional cost to Contract.
 - .8 Specification does not generally indicate specific number of items or amounts of material required. Specification is intended to provide product data and installation requirements. Refer to schedules, Drawings (layouts, riser diagrams, schematics, details) and Specification to provide correct quantities. Singular may be read as plural and vice versa.
 - .9 Starter/motor control centre (MCC)/variable frequency drive (VFD) schedule drawings are both mechanical and electrical, and apply to work of Mechanical Divisions and Electrical Divisions. Be responsible for reviewing starter, MCC, VFD, and motor specification requirements prior to Bid submission. Confirm and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.
 - .10 Drawings and Specifications have been prepared solely for use by party with whom Consultant has entered into a contract and there are no representations of any kind made by consultant to any other party.
 - .11 In the case of discrepancies between the drawings and specifications, documents will govern in order specified in "General Conditions", however, when scale and date of drawings are same, or where discrepancy exists within specification, most costly arrangement will take precedence.

1.5 Metric and Imperial Measurements

- .1 Generally, both metric and imperial units of measurement are given in Sections of Specification governed by this section. Measurement conversions may be generally "soft" and rounded off. Confirm exact measurements based on application. Where measurements are related to installation and onsite applications, confirm issued document measurements with applicable local code requirements, and/or as applicable, make accurate measurements onsite. Where significant discrepancies are found, immediately notify Consultant for direction.

1.6 Work Standards

- .1 Where any code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction is quoted it means, unless otherwise specifically noted, latest published edition at time of submission of Bids adopted by and

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- enforced by local governing authorities having jurisdiction. Include for compliance with revisions, bulletins, supplementary standards or amendments issued by local governing authorities.
- .2 Where regulatory codes, standards and regulations are at variance with Drawings and Specification, more stringent requirement will apply unless otherwise directed by Consultant.
 - .3 Supplementary mandatory specification and requirements to be used in conjunction with project include but are not limited to following:
 - .1 Air-Conditioning, Heating and Refrigeration Institute (AHRI);
 - .2 Air Movement and Control Association (AMCA);
 - .3 American Iron and Steel Institute (AISI);
 - .4 American National Standards Institute (ANSI);
 - .5 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE);
 - .6 American Society of Mechanical Engineers (ASME);
 - .7 American Society of Testing and Materials (ASTM);
 - .8 American Water Works Association (AWWA);
 - .9 Associated Air Balance Council (AABC);
 - .10 Building Industry Consulting Services, International (BICSI);
 - .11 Canadian General Standards Board (CGSB);
 - .12 Canadian Standards Association (CSA);
 - .13 Electrical and Electronic Manufacturers Association of Canada (EEMAC);
 - .14 Electrical Safety Authority (ESA);
 - .15 Electronic Industries Association (EIA);
 - .16 Factory Mutual Systems (FM);
 - .17 International Standards Organization (ISO);
 - .18 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS);
 - .19 National Building Code of Canada (NBC);
 - .20 National Electrical Manufacturers Association (NEMA);
 - .21 National Environmental Balancing Bureau (NEBB);
 - .22 National Fire Protection Association (NFPA);
 - .23 National Standards of Canada;
 - .24 NSF International;
 - .25 Occupational Health and Safety Act (OHSA);
 - .26 Ontario Building Code (OBC);
 - .27 Ontario Electrical Safety Code (OESC);
 - .28 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA);
 - .29 Technical Standards and Safety Authority (TSSA);

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- .30 Thermal Insulation Association of Canada (TIAC);
- .31 Underwriters' Laboratories of Canada (ULC);
- .32 Workplace Hazardous Materials Information System (WHMIS);
- .33 Material Safety Data Sheets by product manufacturers;
- .34 local utility inspection permits;
- .35 Codes, standards, and regulations of local governing authorities having jurisdiction;
- .36 additional codes and standards listed in Trade Sections;
- .37 Owner's standards.
- .4 Provide applicable requirements for barrier free access in accordance with latest edition of local governing building code.
- .5 Where any governing Code, Regulation, or Standard requires preparation and submission of special details or drawings for review they are to be prepared and submitted to appropriate authorities. Be responsible for costs associated with these submittals.
- .6 Unless otherwise specified, install equipment in accordance with equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions.
- .7 Work is to be performed by journeyperson tradesmen who perform only work that their certificates permit, or by apprentice tradesmen under direct on site supervision of experienced journeyperson tradesman. Journeyperson to apprentice ratio is not to exceed ratio determined by the Board as stated in Ontario College of Trades and Apprenticeship Act or local equivalent governing body in Place of the Work.
- .8 Journeyperson tradesmen are to have a copy of valid trade certificates available at site for review by Consultant at any time.
- .9 Experienced and qualified superintendent is to be on-site at times when work is being performed.
- .10 Coordinate work inspection reviews and approvals with governing inspection department to ensure that construction schedule is not delayed. Be responsible for prompt notification of deficiencies to Consultant and submission of reports and certificates to Consultant.
- .11 Properly protect equipment and materials on site from damage due to elements and work of trades, to satisfaction of Consultant. Equipment and materials are to be in new condition upon Substantial Performance of the Work.
- .12 Mechanical piping system work, including equipment, must comply in all respects with requirements of local technical standards authorities and CSA B51, Boiler, Pressure Vessels and Pressure Piping Code. Where required, mechanical work products must bear a CRN number.
- .13 Electrical items associated with mechanical equipment are to be certified and bear stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, etc., or bear a stamp to indicate special electrical utility approval.

1.7 Permits, Certificates, Approvals and Fees

- .1 Contact and confirm with local authorities having jurisdiction including utility providers, requirements for approvals from such authorities. Obtain and pay for permits,

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certificates, and approvals required to complete Work.

- .2 Be responsible for ensuring that authorities having jurisdiction which require on-site inspection of work, have ample notification to perform inspection, with sufficient lead time to correct deficiencies in a manner that will not impede schedule of completion of Work. If any defect, deficiency or non-compliant is found in work by inspection, be responsible for costs of such inspection, including any related expenses, making good and return to site, until work is passed by governing authorities.
- .3 Submit to Consultant, approval/inspection certificates issued by governing authorities to confirm that Work as installed is in accordance with rules and regulations of local governing authorities and are acceptable.
- .4 Include in each copy of operating and maintenance instruction manuals, copies of approvals and inspection certificates issued by regulatory authorities.

1.8 Requirements for Contractor Retained Engineers

- .1 Professional engineers retained to perform consulting services with regard to Project work, i.e. seismic engineer, fire protection engineer or structural engineer, are to be members in good standing with local Association of Professional Engineers and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of governing authorities in Place of the Work.
- .2 Retained engineer's professional liability insurance is to protect Contractor's consultants and their respective servants, agents, and employees against any loss or damage resulting from professional services rendered by aforementioned consultants and their respective servants, agents, and employees in regards to the Work of this Contract.
- .3 Unless otherwise specified in Division 00 or 01, liability insurance requirements are as follows:
 - .1 coverage is to be a minimum of \$1,000,000.00 CDN inclusive of any one occurrence;
 - .2 insurance policy is not to be cancelled or changed in any way without insurer giving Owner minimum thirty days written notice;
 - .3 liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the Place of the Work;
 - .4 retained consultants are to ascertain that sub-consultants employed by them carry insurance in the form and limits specified above;
 - .5 evidence of the required liability insurance in such form as may be required is to be issued to Owner, Owner's Consultant, and Municipal Authorities as required prior to commencement of aforementioned consultant's services.

1.9 Interpretation of Drawings

- .1 The drawings upon which this contract is based show the arrangements, general design and extent of the piping, ductwork and other systems. These systems are suitably outlined on the drawings with regard to sizes, locations, general arrangement and installation details. The mains and connections thereto are shown more or less in diagram, except where in certain cases, the drawings may include details giving the exact locations and arrangements required. All piping and ductwork shall be concealed unless shown otherwise. The Mechanical Contract Drawings do not intend to show Architectural or Structural details.
- .2 Where any parts of the system and/or pieces of equipment are located by dimensions on the drawings, said dimensions shall be checked and verified in the field. Each Division

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shall make without additional charge or expense to the Owner, any necessary changes, additions or offsets to the runs to accommodate structural conditions. The Consultant shall be notified immediately, and his authority secured in writing for such revisions before proceeding with the work.

- .3 As the work progresses, and before installing fixtures and other fittings and equipment which may interfere with the work of other trades, each Contractor shall consult with the Consultant and obtain detail drawings or instructions for the exact location of such equipment.

1.10 Existing Services

- .1 Where work involves breaking into or connecting existing services, carry out work at times directed by governing authorities, with minimum of disturbance to the premises and its operation.
- .2 Before commencing work, establish location and extent of service lines in area of work and notify Consultant of finding.
- .3 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.
- .4 Remove abandoned service lines. Cap or otherwise seal lines at cut-off points, in manner approved by authorities having jurisdiction over service.
- .5 Record locations of maintained, re-routed and abandoned service lines. The sub-contractors concerned shall provide this Division with all necessary dimensions required to accurately locate those services.
- .6 Where the location of any of these utilities has been shown on the plans, such information is not guaranteed. It is the responsibility of this Division to verify locations, elevations, etc., immediately after they move on the site. If for any reason the information obtained necessitates changes in procedures or design, they must advise the Consultant at once. If this verification of existing conditions is not done at the outset and any problems arise, the responsibility for same is entirely this Division's.
- .7 Where it is necessary to temporarily shut down equipment or services serving essential areas, this Division shall include premium costs to ensure the work force is scheduled for "round the clock" operation in order to minimize disruption and equipment downtime.

1.11 Discrepancies & Omissions

- .1 The specifications are to be considered as an integral part of the plans which accompany them; neither the plans nor the specifications shall be used alone. Any item or subject omitted from one, but which is mentioned or reasonably implied in the other, shall be considered as properly and sufficiently specified, and must therefore, be provided. Notify the Consultant in writing of any discrepancy between the drawings and the Specifications, or omissions from Documents, or having doubt as to their meaning or intent. Misinterpretations of either the plans or the specifications shall not relieve this Division of responsibility.
- .2 Carefully examine Documents and visit the site of the building to determine and review existing site conditions that will or may affect work and become thoroughly familiar with all the conditions to be met in carrying out the work covered by these specifications. Include for such conditions in Bid Price. No extras will be allowed for failure to properly evaluate conditions which affect the scope of the work included in Divisions 21, 22, 23 and 25.
- .3 Report to Consultant, prior to Bid Submittal, any existing site condition that will or may

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affect performance of work as per Documents. Failure to do so will not be grounds for additional costs.

1.12 Workplace Safety

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for products where required, and maintain one copy at site in a visible and accessible location available to personnel.
- .2 Comply with requirements of Occupational Health and Safety Act and other regulations pertaining to health and safety, including worker's compensation/insurance board and fall protection regulations. When working in confined spaces, comply with requirements of Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces" and any other applicable Ministry of Labour requirements.
- .3 If at any time during course of existing building work, hazardous materials other than those identified in Documents and pertaining to Project Scope of Work, are encountered or suspected that were not identified as being present and which specific instructions in handling of such materials were not given, cease work in area in question and immediately notify Consultant. Comply with local governing regulations with regards to working in areas suspected of containing hazardous materials. Do not resume work in affected area without approval from Consultant.

1.13 Planning and Layout of Work

- .1 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.
- .2 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions. Generally, order of right of way for services to be as follows:
 - .1 piping requiring uniform pitch;
 - .2 piping 100 mm (4") dia. and larger;
 - .3 large ducts (main runs);
 - .4 cable tray and bus duct;
 - .5 conduit 100 mm (4") dia. and larger;
 - .6 piping less than 100 mm (4") dia.;
 - .7 smaller branch ductwork;
 - .8 conduit less than 100 mm (4") dia..
- .3 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify Consultant where headroom or ceiling space appears to be inadequate prior to installation of work.
- .4 Do not use Contract Drawing measurements for prefabrication and layout of piping, sheet metal work and such other work. Locations and routing are to generally be in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established bench marks for both horizontal and vertical measurements. Confirm inverts, coordinate with and make allowances for work of other trades. Accurately layout work, and be entirely responsible for work installed in accordance with layout drawings. Where any invert, grade, or size is at variance with Contract Drawings, notify Consultant prior to proceeding with work.

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- .5 Prepare plan and interference drawings (at a minimum drawing scale of 1:50 or 1/4"=1' 0") of work for coordination with each trade Contractor. Arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with plan drawings so that trades may make use of section drawings. Section drawings to indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Consultant, engineering drawings for this use. Contractors' interference drawings are to be distributed among other Trade Contractors. Submit drawings to Consultant for review. Failure of General Contractor to prepare and coordinate overall interface drawings of trades does not relieve respective Division Contractor of responsibility to ensure that work is properly planned and coordinated.
- .6 Carry out alterations in arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with Contract Documents, in order to conceal work behind finishes, or to allow installation of other work, without additional cost. In addition, make necessary alterations in other work required by such alterations, without additional cost.
- .7 Shut-off valves, balancing devices, air vents, equipment and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.
- .8 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were missed due to lack of coordination.

1.14 Coordination of Work

- .2 Review Contract Documents and coordinate work with work of each trade. Coordination requirements are to include but not be limited to following:
 - .1 requirements for openings, sleeves, inserts and other hardware necessary for installation of work;
 - .2 concrete work such as housekeeping pads, sumps, bases, etc., required for work, and including required dimensions, operating weight of equipment, location, etc.;
 - .3 depth and routing of excavation required for work, and requirements for bedding and backfill;
 - .4 wiring work required for equipment and systems but not specified to be done as part of mechanical work, including termination points, wiring type and size, and any other requirements.
- .2 Ensure materials and equipment are delivered to site at proper time and in such assemblies and sizes so as to enter into building and be moved into spaces where they are to be located without difficulty.
- .3 Wherever possible, coordinate equipment deliveries with manufacturers and/or suppliers so equipment is delivered to site when it is required, or so it can be stored within building, subject to available space as confirmed with Owner, and protected from elements.
- .4 Ensure proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Comply with code requirements with regards to access space provision around equipment. Remove and replace any equipment which does not meet this requirement.
- .5 Where work is to be integrated or is to be installed in close proximity with work of other trades, coordinate work prior to and during installation.

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1.15 Electrical Wiring & Wiring Diagrams

- .1 All motors for equipment under this Division will be by this Division. All starters/VFDs shall be supplied by this Division and installed by Division 26. All switches and power wiring will be provided by Division 26. Where electrical requirements for equipment exceed the provisions described in electrical specifications, this Contractor shall provide labour and material as required to complete the installation. All motors, switches and equipment shall be of Canadian manufacturer and as per Section 20 05 10.
- .2 Provide with shop drawings, a comprehensive wiring diagram for all mechanical equipment requiring review. Shop drawings will not be reviewed unless accompanied by the wiring diagrams.
- .3 In addition to the wiring diagrams provided by the suppliers of the equipment, this Division shall engage an experienced Mechanical/Electrical Designer to draw wiring diagrams specifically for this project, showing each piece of electrically-wired mechanical equipment that is supplied or connected to by this Division. The drawings shall be bound in a three-ring binder entitled 'Wiring Diagrams' (three copies required). The drawings shall include the following:
 - .1 8-1/2" x 11" or 17" x 11" sheet size with drawing title, job title, drawing number, date, name of draftsman and designer
 - .2 Index for the above
 - .3 Schematic wiring diagram of each electrically connected item of equipment labelled with the specific designation used on the project drawings (i.e. P-1, AHU-1, RF-1, EF-1, H-1, CH-1, UH-1, FC-1 etc.).
 - .4 Showing motor HP, kW, voltage
 - .5 Terminal block designation and connection number
 - .6 Starter and relays for mechanical equipment supplied and installed by Division 26
 - .7 Power panel number and circuit number of feeder
 - .8 All thermostat, relays, damper motors and controllers, pressure switches and interconnection interlocks. Where the Temperature Controls Sub-Contractor shop drawings show the detailed wiring, these drawings may show the Temperature Controls drawing number references only.
- .4 If all of the information is not available from the shop drawings and project drawings, the information shall be determined from field visits.
- .5 This section of the work shall be completed by Division 25.
- .6 Refer to Division 26, 'Wiring for Mechanical Equipment' for wiring of mechanical equipment.

1.16 Openings

- .1 Supply opening sizes and locations to Consultant to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.
- .2 No openings are permitted through completed structure without written approval of Consultant. Show required openings on a copy of structural drawings. Identify exact locations, elevations, and size of proposed openings and submit to Consultant for review, well in advance of doing work.
- .3 Prior to leaving site at end of each day, walk through areas of work and check for any

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openings, penetrations, holes, and/or voids created under scope of work of project, and ensure that any openings created under scope of work have been closed off, fire-stopped and smoke-sealed. Unless directed by Owner and coordinated with Consultant, do not leave any openings unprotected and unfinished overnight.

1.17 Equipment Loads

- .1 Supply equipment loads (self-weight, operating weight, housekeeping pad, inertia pads, etc.) to Consultant, via shop drawing submissions, prior to construction.
- .2 Where given choice of specific equipment, actual weight, location and method of support of equipment may differ from those assumed by Consultant for base design. Back-check equipment loads, location, and supports, and include necessary accommodations.
- .3 Where supporting structure consists of structural steel framing, it is imperative that equipment loads, location, and method of support be confirmed prior to fabrication of structural steel. Be responsible for confirming locations of equipment with Consultant prior to construction.

1.18 Products

- .1 Be responsible for ordering of products (equipment and materials) in a timely manner in order to meet project-scheduling timelines. Failure to order products to allow manufacturers sufficient production/delivery time to meet project-scheduling timelines is an unacceptable reason to request for other suppliers or substitutions.
- .2 Provide Canadian manufactured products wherever possible or required and when quality and performance is obtainable at a competitive price. Products are to be supplied from manufacturer's authorized Canadian representative, unless otherwise noted. Unless otherwise specified, products are to be new and are to comply with applicable respective Canadian standards. References to UL listings of products to include requirements that products are to be also Underwriters Laboratories of Canada (ULC) listed for use in Canada. Products are to meet or exceed latest ANSI/ASHRAE/IES 90.1 standards, as applicable. Do not supply any products containing asbestos materials or PCB materials.
- .3 Systems and equipment of this Project are to be "State of the Art" and be most recent and up to date series/version of product that is available at time of shop drawing review process. Products that have been stored or "on shelf" for an extended period of time will not be accepted. Software is to be of latest version available and be provided with updates available at time of shop drawing review process. Systems are to be designed such that its software is backwards compatible. Future upgrades are not to require any hardware replacements or additions to utilize latest software.
- .4 Products scheduled and/or specified have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for any product specified by manufacturer's name and model number. Where acceptable manufacturers are listed, first name listed is base specified company. Bid Price may be based on products supplied by any of manufacturers' base specified or named as acceptable for particular product. If acceptable manufacturers are not stated for a particular product, base Bid Price on product supplied by base specified manufacturer.
- .5 Documents have been prepared based on product available at time of Bidding. If, after award of Contract, and if successful manufacturer can no longer supply a product that meets base specifications, notify Consultant immediately. Be responsible for obtaining other manufacturers product that complies with base specified performance and criteria and meets project timelines. Proposed products are subject to review and consideration by Consultant and are considered as substitutions subject to a credit to Contract. In

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addition, if such products require modifications to room spaces, mechanical systems, electrical systems, etc., include required changes. Such changes are to be submitted in detail to Consultant for review and consideration for acceptance. There will be no increase in Contract Price for revisions. Above conditions supplement and are not to supersede any specification conditions with regards to substitutions or failure to supply product as per issued documents.

- .6 Listing of a product as "acceptable" does not imply automatic acceptance by Consultant and/or Owner. It is responsibility of Contractor to ensure that any price quotations received and submittals made are for products that meet or exceed specifications included herein.
- .7 If products supplied by a manufacturer named as acceptable are used in lieu of base specified manufacturer, be responsible for ensuring that they are equivalent in performance and operating characteristics (including energy consumption if applicable) to base specified products. It is understood that any additional costs (i.e. for larger starters, larger feeders, additional spaces, etc.), and changes to associated or adjacent work resulting from provision of product supplied by a manufacturer other than base specified manufacturer, is included in Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of base specified equipment and dimensions of such equipment differs from base specified equipment, prepare and submit for review accurately dimensioned layouts of rooms affected, identifying architectural and structural elements, systems and equipment to prove that equipment in room will fit properly meeting design intent. There will be no increase in Contract Price for revisions.
- .8 In addition to manufacturer's products base specified or named as acceptable, other manufacturers of products may be proposed as substitutions to Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products base specified or named as acceptable. Certify in writing to Consultant that proposed substitution meets space, power, design, energy consumption, and other requirements of base specified or acceptable product. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of proposed substitution. Consultant has sole discretion in accepting any such proposed substitution of product. Do not order such products until they are accepted in writing by Consultant.
- .9 Where products are listed as "or approved equal", certify in writing that product to be used in lieu of base specified product, at least meets space, power, design, energy consumption, and other requirements of base specified product and is equivalent or better than base specified product. When requested by Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or approved equal" products is at sole discretion of Consultant. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of approved equal product. There must be no increase in Contract price due to Consultant's rejection of proposed equivalent product.
- .10 Whenever use of product other than base specified product is being supplied, ensure corresponding certifications and product information (detailed catalogue and engineering data, fabrication information and performance characteristics) are submitted to Consultant for review. Failure of submission of these documents to Consultant in a timely manner to allow for review will result in base specified product to be supplied at Consultant's discretion, at no additional cost to Contract.
- .11 Products supplied by a manufacturer/supplier other than a manufacturer listed as acceptable may be considered for acceptance by Consultant if requested in writing with

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full product documentation submitted, a minimum of 10 working days prior to Bid closing date.

- .12 Any proposed changes initiated by Contractor after award of Contract may be considered by Consultant at Consultant's discretion, with any additional costs for such changes if approved by Consultant, and costs for review, to be borne by Contractor.
- .13 Whenever use of product other than based specified products or named as acceptable is being supplied, time for process of submission of other products and Consultant's review of products will not alter contract time or delay work schedule.

1.19 Material Substitution

- .1 The following requirements are aimed to establish a certain quality of materials to be used.
- .2 Besides, the objective is not to eliminate the loyal competition in the tender process applied to materials and substitute products.
- .3 The equivalences will be accepted only on the following conditions:
 - .1 Equivalence must be submitted before the contract;
 - .2 Proofs of equivalences will be required and this at the Supplier's fees;
 - .3 Samples of the proposed material or equipment and the specified material or equipment may be required;
 - .4 The main points of comparison are: construction, efficiency, capacity, dimensions, weight, service access, minimal standard, availability and delivery of spare parts, maintenance, delivery deadlines, origin of the product, etc.
- .4 Any equivalence requiring an increase of the installation time or a surplus of auxiliary materials or any modification which would ensue from it, will not justify an additional payment for the Contractor. The basic price has to include all these changes.
- .5 Documents having been prepared with the dimensions and the characteristics of devices specified in the specification, the Contractor is solely responsible to make sure that the equivalence he proposes can settle down without change in the plans, not so as to modify the conditions of the original design and the spirit of the contract, and has to verify that all dimensions of the equivalences are suitable to the project. He has to inform the Engineer, in writing, that the equipment which he suggests as equivalence meets these requirements and to ask for its approval.
- .6 The Consultant reserves the right to accept or to refuse one or several equivalences (materials considered equivalent by the Contractor); his decision is final. The basic price of the submission will be adjusted more or less, according to the acceptance of the Engineer.

1.20 Access Panels & Doors

- .1 **For Non-Fire-Rated Separation (Drywall Ceilings & Walls):**
 - .1 Supply for finished drywall ceilings and walls, APS (Bauco-Plus II) recessed access door of a suitable size to provide access to plumbing cleanouts and for servicing dampers, valves and equipment which will be concealed.
 - .2 Access door to be designed for flush installation in drywall surfaces. Access door is recessed 1" to receive drywall. The flange of the door is a textured galvanized steel tapping bend with pre-punched holes. Drywall compound is applied over the beading at the same time as the drywall joints are finished
 - .3 Door to be 16 gauge prime-coated steel with 14 gauge steel frame and

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screwdriver operated can latch.

- .4 Prime Mechanical Contractor shall include for the installation of all access doors supplied by Division 21, 22, 23 and 25. Engage and pay the respective General Trade on site to install same.

.2 For Non-Fire-Rated Separation (Not Drywall Ceilings & Walls):

- .1 Supply for finished ceiling or wall surfaces that are not of drywall construction, Smillie, McAdams Summerlin Limited, Le Hage (Ancon Industries Incorporated) access doors of a suitable size to provide access to plumbing cleanouts and for servicing dampers, valves and equipment which will be concealed. Minimum size for reach-in access to be 12" x 12" (300 mm x 300 mm) and 18" x 18" (450 mm x 450 mm) for man access.
- .2 Door and frame to be 16 gauge prime-coated steel with concealed hinges and positive locking and self-opening screwdriver lock.
- .3 Prime Mechanical Contractor shall include for the installation of all access doors supplied by Divisions 21, 22, 23, 25. Engage and pay the respective General Trade on site to install same.

.3 Fire-Rated Separations:

- .1 Supply access doors in fire-rated ceiling assemblies, walls and shafts. Access doors shall be Smillie, McAdams Summerlin Limited, Le Hage (Ancon Industries Incorporated), ULC listed, manufactured and installed in accordance with NFPA-80.
- .2 Door to be complete with 16 gauge steel frame with concealed continuous hinge and key-operated lock and self closer, double wall 20 gauge prime-coated steel door with 2" (50 mm) thick insulation.
- .3 ULC rating 1-1/2 hours, temperature rise maximum 250°F (120°C) in thirty (30) minutes.
- .4 Prime Mechanical Contractor shall include for the installation of all access doors supplied by Divisions 21, 22, 23, 25. Engage and pay the respective General Trade on site to install same.

- .4 For access doors located in the Operating Room ceiling and in the soffit beneath the Operating Room addition, refer to architectural for final locations and details.

- .5 Size access panel doors to provide adequate access and correspond with the type of structural and architectural finish.

- .6 Ensure proper fire resistance rating of doors/panels in fire separations.

- .7 Provide the following:

- .1 Type RW recessed for "SG" board in wet areas.
- .2 Type TM flush mount for tile and masonry.
- .3 Type WB flush for wall board.

- .8 Materials & Finish:

- .1 Galvanized bonderized steel, phosphate-dipped with baked-on rust inhibitive grey prime finish.
- .2 Stainless steel with No. 4 finish in Shower, Wet Washrooms and Drying Areas.

- .9 Acceptable Products:

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- .1 Le Hage
- .2 Milcor
- .3 Acudor
- .4 Nystrom
- .5 Access Panel Solutions Inc. (Bauco - Plus II) for Drywall

1.21 Concrete Work & Supports

- .1 Installation of concrete bases for all mechanical equipment shall be by this Division.
- .2 Prime Mechanical Contractor shall construct the bases. Provide accurate templates for the concrete trade to pour the bases.
- .3 For equipment suspended from the building structure, provide all structural members, platforms, brace and hanger rods as required. Method of attachment to be reviewed with the Structural Consultant before proceeding with the installation.
- .4 For pre-cast slabs, Prime Mechanical Contractor shall co-ordinate all openings for pipes and ducts with the Precast Concrete Erector. The Precast Concrete Erector shall be responsible for drilling or cutting all holes through precast slabs. Holes through the structural slabs shall be sleeved as specified herein.

1.22 Flashing

- .1 The Prime Mechanical Contractor shall provide flashings for the work of this Division. If not specified, a description is to be supplied for approval.
- .2 Generally, all pipes and small ducts or stacks passing through the roof shall be flashed with an 18 gauge steel sleeve soldered watertight and fastened to the roof deck before the roofing is applied with a minimum of 8" (200 mm) overlap along the roof deck and extending 8" (200 mm) up the pipe or duct, sealed with a weather skirt.
- .3 Vent stacks may be flashed with patented flashing cones provided with the equipment.
- .4 Where large ducts pass through roof, curbs and flashing shall be by this Division where shown on the roofing plan. If not shown, all curbs, flashings and counter flashing are by this Division.

1.23 Painting

- .1 Mechanical equipment, grilles, fans, shall be shop prime coated unless noted to be finish coated. Where the prime coat or finish coat has been marred, touch up the surface.
- .2 Equipment exposed to the exterior weather conditions are to be shop finished with rust-resistant paint or as specified in equipment specification.
- .3 Leave all work in a clean, paintable condition.
- .4 All exposed structural members required for supporting piping, ductwork and equipment shall be galvanized. Where threaded rods are used, they shall be cadmium plated including washers and nuts.
- .5 Paint pipe sleeves one (1) coat primer.
- .6 Paint all relief and drain pipes serving Mechanical equipment, flat black.

1.24 Cutting & Patching

- .1 It is the responsibility of the Prime Mechanical Contractor to install sleeves for piping and ducts, and provide frames for opening for grilles, louvres, fans and similar equipment to

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be built into the existing building. All structural components must have the location, size and proposed method of cutting approved before proceeding.

- .2 Should damage occur to the work of other trades and Divisions, remedial work will be done by the trade who originally installed the work, at the expense of the sub-contractor who caused the damage.
- .3 Where pipes and ducts pass through walls in the existing building, the cutting and patching is by the Prime Mechanical Contractor.
- .4 Co-ordinate work with Division 01 for Firestopping and Smoke Seals.

1.25 Sleeves

- .1 Provide pipe sleeves at points where pipes (plumbing, heating, sprinkler, gas, etc.) pass through masonry of minimum 22 gauge thickness galvanized sheet steel with lock seam joints. Where ducts pass through masonry provide suitable 18 gauge galvanized steel sleeves. Size sleeves on insulated piping or ducts to permit insulation to continue through. Where piping or ducts pass through concrete or frame construction, provide 1/8" (3 mm) thick galvanized iron sleeves. On copper pipe provide copper pipe sleeves.
- .2 Use cast iron or steel pipe sleeves with annular fin continuously welded at midpoint, through foundation walls and where sleeve extends above finished floor.
- .3 Provide 1/8" (3 mm) clearance all around, between sleeve and pipes or between sleeve and insulation and where piping passes below footings, provide minimum clearance of 2" (50 mm) between sleeve and pipe. Backfill up to underside of footing with concrete of same strength as footing.
- .4 Terminate sleeves flush with surface of concrete and masonry and 2" (50 mm) above floors. Not applicable to concrete floors on grade.
- .5 For pipes passing through roofs, use cast iron sleeves with caulking recess and flashing clamp device. Anchor sleeves in roof construction; caulk between sleeve recess and pipe; fasten roof flashing to clamp device; make watertight durable joint.
- .6 Fill voids around pipes.
 - .1 Where sleeves pass through walls or floors, caulk space between insulation and sleeve or between pipe and sleeve with waterproof, fire-retardant, non-hardening mastic. Seal space at each end of sleeve with waterproof, fire-retardant, non-hardening mastic.
 - .2 Ensure no contact between copper pipe and ferrous sleeve.
- .7 Co-ordinate work with Division 01 for Firestopping and Smoke Seals.

1.26 Escutcheons & Plates

- .1 Provide on exposed pipes passing through finished walls, partitions, floor and ceilings.
- .2 Use chrome or nickel-plated brass, solid type with set screws for ceiling or wall mounting.
- .3 Inside diameter shall fit around finished pipe. Outside diameter shall cover sleeve.
- .4 Where sleeve extends above finished floor, escutcheons or plates shall clear sleeve extension.
- .5 Secure to pipe or finished surface.

1.27 Dielectric Couplings

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- .1 Provide wherever pipes of dissimilar metals are joined.
- .2 Provide insulating unions for pipe sizes 2"Ø (50 mm) and smaller, and flanges for pipe sizes 2-1/2" (65 mm) and larger. Brass adaptors and bronze valves will not be accepted.
- .3 Provide an isolating separation wherever piping may touch dissimilar metal studs, joists, concrete, etc.

1.28 Fire Stopping

- .1 The Prime Mechanical Contractor is responsible for all fire stopping related to the work of Division 21, 22, 23 and 25 including, but not limited to, the ductwork, piping and control wiring.

1.29 Impeller, Sheave & Belt Changes

- .1 The Prime Mechanical Contractor to carry the costs for pump impeller, fan sheave and belt changes. See Section 20 05 50 - Testing, Adjusting and Balancing.

1.30 Non-Ferrous Materials

- .1 Materials within designated imaging rooms to be of non-ferrous construction as coordinated with Consultant. Devices, system components, etc., utilized to be approved for use in designated imaging room type applications. Methods of construction to take into consideration use of non-ferrous materials. Ultimate approval of any materials, devices or components, or methods of construction to be at imaging system manufacturer's discretion. Coordinate and confirm final requirements with successful imaging system supplier.

1.31 Scaffolding, Hoisting and Rigging

- .1 Unless otherwise specified or directed, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to review by and coordination with Consultant. Include for the cost of dismantling and reassembling equipment, where required, to the manufacturer's approval.
- .2 Direct this work by qualified people normally engaged in rigging, hoisting and handling of equipment.
- .3 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.
- .4 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from Consultant.

1.32 Protection

- .1 Protect work from damage. Securely plug or cap open ends of conduits, pipes, ducts or equipment to prevent entry of dirt, dust, debris, water, snow or ice. Cover all items cast into concrete floors/walls such as floor drains, cleanouts, etc., prior to pour, with heavy plastic tape or duct tape. Clean all piping, ducting, conduits and equipment inside and outside before testing.
- .2 Material stored on site shall be protected from weather and kept dry and clean at all times. Take care to avoid corrosion of metal parts. Protect all bearings and motors from damage due to moisture and dust. Equipment not yet in operation shall be turned over at least at monthly intervals to prevent bearing deterioration.

1.33 Rights Reserved

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- .1 Rights are reserved to furnish any additional detail drawings which, in the judgement of the Consultant, may be necessary to clarify the Work and such drawings shall form a part of the Contract.

1.34 Superintendence

- .1 Maintain at this job site, at all times, qualified personnel and supporting staff with proven experience in erecting, supervising, testing and adjusting projects of comparable nature and complexity.

1.35 Co-Ordination

- .1 The Prime Mechanical Contractor is responsible for co-ordinating the mechanical work herein to suit Project Phasing Schedule.
- .2 Co-ordinate all Mechanical Work with the work of any other Divisions to avoid conflicts. Be responsible for modifying the work of this Division to accommodate space conflicts.
- .3 Failure to co-ordinate will result in installed work being removed and new work put in place without cost to the Owner.

1.36 Maintenance

- .1 Furnish spare parts in accordance with Division 01 requirement and as follows:
 - .1 One set of packing for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One filter cartridge or set of filter media for each filter or filter bank in addition to final operation set.
 - .4 One glass for each gauge glass.
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Division 01 requirement.
- .3 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.37 Delivery, Storage & Handling

- .1 Transport, store and handle the materials in conformance with the manufacturer's instructions.
- .2 Delivery and receipt:
 - .1 Deliver the materials to the job site in their original packaging. The name and the address of the manufacturer marked must be labelled on the packaging.
- .3 Storage and protection:
 - .1 Store the materials in a dry environment.
 - .2 Store the materials in the temperature and humidity conditions recommended by the manufacturer, and protect them from exposure to extreme weather conditions.
- .4 Packaging waste management: recover the packaging waste so that it may be re-used or recycled or reclaimed by the manufacturer. This includes pallets, lockers, packing and other packing material.

1.38 Tendering Instructions

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- .1 Refer to the General Conditions for the Instructions to Bidders.
- .2 The Prime Mechanical Contractor agrees to employ those subcontractors proposed in the Mechanical Form(s) of Tender and accepted by the Owner at the signing of the Contract.
- .3 The Owner may, for reasonable cause, object to the use of a proposed subcontractor and consequently, may require the Prime Mechanical Contractor to employ one of the other subcontractor bidders.
- .4 In the event that the Owner requires a change from a proposed subcontractor, originally proposed by the Prime Mechanical Contractor, the Contract Price shall be adjusted by the difference in cost.
- .5 The Prime Mechanical Contractor shall not be required to employ as a subcontractor, a firm to whom he may reasonably object.
- .6 Work of subcontractors named at the time of Tender or substitutions authorized by the Owner will be recognized as being in accordance with the Contract Documents and any payments will be approved by the Owner, only to such subcontractors.

1.39 Changes in the Work

- .1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity or type of work from that required by Contract Documents, prepare and submit to Consultant for approval, a quotation being proposed cost for executing change or revision.
- .2 Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.
- .3 If overhead and profit percentages are not specified in Division 00 or 01, but allowable under Contract as confirmed with Consultant prior to contract signing, then allowable maximum percentages for overhead and profit are to be 7% and 5% respectively.
- .4 Unless otherwise specified in Divisions 00 or 01, following additional requirements apply to all quotations submitted:
 - .1 when change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work;
 - .2 material costs are not to exceed those published in local estimating price guides;
 - .3 mechanical material labour unit costs are to be in accordance with Mechanical Contractors Association of America Labor Estimating Manual, less 25%;
 - .4 electrical material labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labor Units at difficult level, less 25%;
 - .5 costs for journey person and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work;
 - .6 cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision, and change or revision must be such that site superintendent's involvement is necessary;
 - .7 costs for rental tools and/or equipment are not to exceed local rental costs;

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- .8 overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals;
- .9 quotations, including those for deleted work, to include a figure for any required change to Contract time.
- .5 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.
- .6 Make requests for changes or revisions to work to Consultant in writing and, if Consultant agrees, will issue Notice of Change.
- .7 Do not execute any change or revision until written authorization for the change or revision has been obtained from Consultant.

1.40 Progress Payment Breakdown

- .1 Prior to submittal of first progress payment draw, submit a detailed breakdown of work cost to assist Consultant in reviewing and approving progress payment claims.
- .2 Payment breakdown is subject to Consultant's approval and progress payments will not be processed until an approved breakdown is in place. Breakdown is to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including testing, adjusting and balancing, system testing and verification, and project closeout submittals.
- .3 Indicate equipment, material and labour costs for site services (if applicable) and indicate work of each trade in same manner as indicated on progress draw.

1.41 Notice for Required Field Reviews

- .3 Whenever there is a requirement for Consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 5 working days' notice in writing to Consultant.
- .4 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.
- .5 Do not conceal work until Consultant advises that it may be concealed.
- .6 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

1.42 Submittals

- .1 Submittals: in accordance with Division 01.
- .2 Shop drawings to show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
- .3 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.

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- .3 Points of operation on performance curves.
- .4 Manufacturer to certify current model production.
- .5 Certification of compliance to applicable codes.
- .4 In addition to transmittal letter referred to in Division 01: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .5 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Division 01.
 - .2 Operation and maintenance manual approved by, and final copies deposited with, Consultant before final inspection.
 - .3 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .5 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 20 05 50 - Testing, Adjusting and Balancing.
 - .6 Approvals:
 - .1 Submit two (2) copies of draft Operation and Maintenance Manual to Consultant for review. Submission of individual data will not be accepted unless directed by Consultant.
 - .2 Make changes as required and re-submit as directed by Consultant.
 - .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
 - .8 As-built drawings:

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- .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
- .2 Identify each drawing in lower right-hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
- .3 Submit to Consultant for review and make corrections as directed.
- .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
- .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.
- .10 Site records:
 - .1 Engineer will provide one set of mechanical drawings. Mark changes as work progresses and as changes occur.
 - .2 Transfer information to reproducible, revising reproducible to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.

1.43 Record Drawings

- .1 The Consultant will provide an extra set of whiteprints to be marked up by this Division as the job progresses, showing all changes and deviations from the plans, so that on completion of the job, the Consultant will have a record of the exact location of all piping, ductwork and equipment. These drawings shall be available during construction at all times and will be reviewed monthly by the Consultant.
- .2 Record drawings shall locate all concealed shut-off valves, dampers, control valves and concealed air vents.
- .3 The Consultant will provide to the Prime Mechanical Contractor the AutoCAD disk for a fee. The Prime Mechanical Contractor will be required to sign "Transfer of Files on Electronic Media" Form and pay the fee in order to receive the files. A sample of this form is attached to the section. Return completed disks to the Consultant with Maintenance Manuals.

1.44 Interference Drawings

- .1 Before shop fabrication begins or undertaking installation work inside the building, prepare an integrated set of mechanical interference sketches, where indicated on the drawings.
- .2 These sketches shall be prepared by the Prime Mechanical Contractor with the co-operation of other trades and shall show the location or space allocated for the work of each trade.
- .3 Submit two (2) copies of detailed interference sketches, showing structural members, electrical conduits, devices and all Mechanical elements to the Consultant for review and general approval before proceeding with the work.
- .4 Copies of these reviewed interference drawings shall be submitted to all trades, the General Contractor, the Architect, and the Consultant, and general approval shall be obtained before the space allotment and installation.

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- .5 As a minimum, interference drawings shall be made for all areas of mechanical equipment rooms, duct shafts and corridor ceiling spaces.
- .6 Work that has been installed before review of interference drawings, and has been determine that it is in conflict with the building, shall be removed from the site at no extra cost to the Owner. The work, approved by the Consultant, shall be installed at no extra cost to the Owner.

1.45 Materials & Equipment - Acceptable Products, Base Bid, Alternate Products, Unsolicited Alternates

- .1 Provide materials and equipment in accordance with Division 01.
- .2 Equipment and material to be CSA certified and manufactured to standards specified herein.
- .3 Factory assemble control panels and component assemblies.
- .4 The Specification indicates Acceptable Product manufacturers (or Acceptable Manufacturers) for various products, materials and systems which make up the mechanical work. The Tender Price shall be based on any of the "Acceptable Products".
- .5 The net dollar deduction from the Tender Price if the alternate is accepted. This value shall reflect all costs associated with the incorporation of the alternate into the work, including any required changes in Architectural, Structural, Electrical and other Mechanical Sections and the Consultants costs of revising the design to suit.
- .6 The Owner reserves the right to accept or reject any or all "Approved Alternates".

1.46 Manufacturers, Shop Drawings & Submittals

- .1 Before fabrication of any materials and/or equipment, submit shop drawings and data sheets covering all items of equipment listed as requiring shop drawings. Shop drawings to be submitted are listed in each section under SUBMITTALS. These will be reviewed and returned to the Contractor. Materials shall not be ordered until "accepted" review has been given.
- .2 The Prime Mechanical Contractor is to consult with the Consultant on the manner in which drawings will be handled. Supply metric information for metric projects.
- .3 Equipment requiring electrical wiring by Division 26 will have the electrical wiring diagrams submitted with the shop drawings. Shop drawings will not be reviewed unless wiring diagrams accompany the equipment drawings.
- .4 For whiteprint-type shop drawings, eight (8) copies as required. For 8-1/2" x 11" fixture cuts, submit eight (8) copies of booklets as required.
- .5 The Prime Mechanical Contractor is to keep track of the shop drawings and the subsequent equipment delivery using a Review Summary Form similar to the form shown below. This form is to be updated and presented at each job meeting until all the equipment is on the job.
- .6 The shop drawings must apply to the equipment under consideration. Advertising literature and comprehensive data sheets are not acceptable.
- .7 The shop drawings must contain the following information: job name, equipment tag, actual dimensions of unit and dimensioned location and size of all field connections, model, performance curves, capacity, HP, voltage and all accessories listed in the specifications and/or being provided, and the operating points of the proposed equipment. Room schedules are to be provided for multiple units.
- .8 The shop drawings submitted for review must first be carefully checked by the Prime

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Mechanical Contractor and bear the Contractor's identification review stamp or signature. Drawings will not be considered otherwise.

- .9 Shop drawing review is for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action shown is subject to the requirements of the contract documents. Contractor is responsible for the dimensions which shall be confirmed and correlated at the job site; fabrication processes and techniques of construction; coordination of his or her work with that of all other trades; and the satisfactory performance of his or her work.
- .10 Shop drawings will be returned "No Exception Taken", "Revise & Resubmit", "Make Corrections Noted, Resubmission Not Required" or "Rejected, Submit Compliant Product/System".
 - .1 "No Exception Taken" Drawings shall be considered as conforming with the design concept.
 - .2 "Make Corrections Noted, Resubmission Not Required" Drawings shall be considered as conforming with the design concept once corrections have been made as noted on the drawings. This notation shall not hold up manufacture. These drawings shall be corrected for final submission with project Maintenance/Operation manuals.
 - .3 "Revise & Resubmit" Drawings shall be considered as conforming with the design concept once corrections have been made as noted on the drawings. These drawings shall be corrected and resubmitted for final review but such resubmission shall not hold up manufacture.
 - .4 "Rejected, Submit Compliant Product/System" These drawings are rejected and work shall not proceed on the manufacture of this equipment. The drawings shall be re-drawn or corrected, and resubmitted with corrections as noted on the drawings or a letter attached thereto.
- .11 All shop drawings must be submitted promptly.

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MECHANICAL SHOP DRAWING REVIEW SUMMARY								
EQUIPMENT DESIGNATION	TARGET SUBMITTAL DATE	EQUIPMENT SUPPLIER			DATE OF DRAWINGS TO CONSULTANT	STATUS	DATE DRAWINGS RETURNED	SCHEDULED DELIVERY DATE
		NAME	CONTACT	PHONE NO.				

STATUS LEGEND

'A' - No Exception Taken

'C' - Make Corrections Noted, Resubmission Not Required

'B' - Revise & Resubmit

'D' - Rejected, Submit Compliant Product/System

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1.47 Operation & Maintenance Manuals

- .1 During the one (1) year guarantee period, commencing after Substantial Completion Letter has been issued by the Consultant's Office, maintain all equipment installed as part of this Division. This is to include lubrication of bearings, cleaning of strainers, etc., except the replacement of air filters and water treatment. This agreement shall be part of the written guarantee. This work shall be carried out in the presence of the owner's representative, and a letter shall be sent to the Consultant stating that this work was carried out. Three (3) maintenance inspections must be carried out by the Prime Mechanical Contractor during this one (1) year period, evenly spaced over the time frame. (after Substantial Completion Letter issued by the Architect). Submit written report to Owner and Consultant after each inspection.
- .2 This maintenance shall continue up to the date of instruction of the Owner's designated representatives, at which time each piece of equipment is to be lubricated and checked in the presence of the Owner's representative(s).
- .3 Not later than three (3) weeks prior to application for inspection by Consultant for Substantial Performance, submit records and maintenance manuals to Consultant.
- .4 Prepare two (2) sets of "letters" sized, hard-cover, three-ring, black, maintenance manuals, containing dimensioned certified prints of each piece of mechanical equipment and Manufacturer's recommended maintenance instructions, air balancing reports, and wiring diagrams. Tabulated at the front of this binder is to be a maintenance schedule for each piece of equipment, and lubricant to be used, and a tabulation of things to be checked at each piece of equipment.
- .5 Maintenance Manuals will be requested by the Consultant shortly after the final submission of all shop drawings. Maintenance manuals must be submitted and reviewed before training of the Owner's personnel and before a final inspection will be carried out.
- .6 In addition to the three (3) maintenance inspections called for in Item .1, the Prime Mechanical Contractor shall organize and attend bi-weekly site meetings with the Owner's Representative to review mechanical system deficiencies. The meetings will commence after substantial completion of the project has been granted and extend for four (4) months for a total of nine (9) meetings. The Prime Mechanical Contractor will take minutes of each meeting indicating status of all mechanical deficiencies. The Prime Mechanical Contractor shall issue copies of the minutes to the Owner and Mechanical Consultant after each meeting.

1.48 Temporary or Trial Usage

- .1 Do not use any permanent Mechanical Systems during construction unless specific written approval is obtained from the Consultant.
- .2 Temporary or trial usage of any mechanical device, machinery, apparatus, 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 so be used.
- .3 Where the Owner permits the use of a system the Prime Mechanical Contractor shall be in charge of and maintain all equipment in accordance with manufacturers instruction at all times the systems are in operation.
- .4 The use of permanent systems shall not invalidate the guarantee or warranty.
- .5 Prior to final acceptance, return all equipment to as new condition and provide supplier certification of same.

Common Work Results for Mechanical

1.49 Time for Completion

- .1 Review the general contract requirement for completion dates. Identify at the time of tender any items which may affect the time for completion.
 - .1 Advise the Consultant if materials and equipment involves longer delivery times than indicated in the schedule.
 - .2 Monitor and expedite delivery of equipment and materials. If necessary, inspect at source of manufacture.
- .2 Be responsible for failure of, or delay in, the delivery of specified equipment.

1.50 Preliminary Testing

- .1 When directed by Consultant, promptly arrange, pay for, and perform site tests on any piece of equipment or any system for such reasonable lengths of time and at such times as may be required to prove compliance with Specification and governing Codes and Regulations, prior to Substantial Performance of the Work.
- .2 When, in Consultant's opinion, tests are required to be performed by a certified testing laboratory, arrange and pay for such tests.
- .3 These tests are not to be construed as evidence of acceptance of work, and it is agreed and understood that no claim for delays or damage will be made for injury or breakage to any part or parts of equipment or system due to test where such injuries or breakage were caused by faulty parts and/or workmanship of any kind.
- .4 When, in Consultant's opinion, tests indicate that equipment, products, etc., are defective or deficient, immediately remove such equipment and/or products from site and replace them with acceptable equipment and/or products, at no additional cost.

1.51 Testing & Adjusting

- .1 Test all piping systems for leaks providing gauges, materials and labour as required. Equipment furnished as part of the permanent installation shall not be used for testing purposes. Before testing, remove all equipment which is not designed to withstand the test pressures. All piping is to be tested before covering is applied, and before backfilling or concealing.
- .2 **Hydrostatic Tests:** All pressure pipe is to be tested as described in each Section. Test pressure shall be maintained for the times noted, during which time the pressure test shall remain constant without pumping.
- .3 **Gravity Piping:** All gravity drainage piping shall be given a ball test and a water test, which must be supervised and inspected by the local Plumbing Inspector.
- .4 All testing shall be done to the satisfaction and approval of the Consultant and the Division shall notify the Consultant forty-eight (48) hours prior to testing.
- .5 Before final payment, test the operation of each system and all equipment installed, make all necessary adjustments and replacements, and demonstrate to the satisfaction of the Consultant that all equipment is operating as intended and without undue noise and vibration.
- .6 All tests must be witnessed by the Owner's Authorized Representative. Failure to do so will result in a re-test.
- .7 If system pumps are used during the system flushing, Prime Mechanical Contractor shall supply and install replacement pump seals in each pump, once flushing is complete and tests results accepted.

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1.52 Start-Up & Instruction

- .1 The Prime Mechanical Contractor shall start-up equipment and operate for a minimum of five (5) days. During this time, adjust controls, clean strainers, replace faulty gauges and thermometers, fasten loose equipment and reduce noise.
- .2 The start-up procedure shall include the completion of the enclosed Equipment Start-Up and Acceptance Check List, which shall be signed by the Mechanical foreman, the Sheet Metal foreman, and Controls foreman where applicable and Electrical foreman certifying they have verified the equipment is ready for acceptance by the Consultant and Owner. When all of the Check Lists have been signed off, the Mechanical foreman and his Sub-Contractors shall demonstrate the operation of the equipment to the Consultant and Owner for sign off acceptance. There shall be an individual Check List sheet for each individual piece of equipment.
- .3 When the sign off procedure is complete, the Prime Mechanical Contractor shall instruct the Owner's designated representative in the operation and maintenance of all equipment. The Consultant and the Board's Commissioning agent shall be present during the operation instruction.

1.53 Operate & Adjust Systems

- .1 Operate all systems to full capacity and verify proper, safe, efficient operation of all parts and each complete system. Oil motors and grease bearings before operating equipment.
- .2 When work is complete and systems are in operation, adjust valves, belt drives, controls and thermostats so that there is an even distribution of cooling and heating throughout. Turn over to Owner necessary keys, handles and operating devices for each system.
- .3 Test for both heating and cooling days. Refer to Section 23 08 01 - Performance Verification Mechanical Piping Systems

1.54 Completion

- .1 Keep the premises in a clean and orderly condition during construction. All waste and unusable materials shall be promptly removed from the site.
- .2 Upon completion of this work, go over the entire installation, clean and polish all fixtures and equipment, and remove all surplus materials and rubbish of every description incidental to this work, leaving the installation neat and orderly.
- .3 Before final payment is made, the following items must be completed:
 - .1 Present to the Consultant "Maintenance Manuals" complete with air and water balancing reports, wiring diagrams and certified equipment prints.
 - .2 Present to the Consultant an as-built record set of drawings and CAD disk.
 - .3 Instruction of Owner's personnel in the maintenance and operation of all new equipment.
 - .4 Present to the Consultant completed Equipment Start-up and Acceptance Checklist.
 - .5 Present to the Consultant Test Certificates and results.
 - .6 Present to the Consultant Valve Tag Charts.
 - .7 Spare filters and frames, labelled and located where directed by the Owner.

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- .8 Present to the Consultant start-up report for fan coil units.
- .9 Present to the Consultant start-up report for air handling unit.
- .10 Present to the Consultant Medical Gas Certification
- .11 Present to the Consultant complete controls commissioning report.
- .12 Present to the Consultant as-built drawings on CAD diskette.
- .13 Maintain a set of approved drawings on site available for review by authorities.
- .14 Perform the above work in a timely manner so as not to interfere with the progress of the project.
- .4 A value of 1% of the total contract price shall be withheld until points .3.1 to .3.14 are completed to the satisfaction of the Consultant.
- .5 **Submit two (2) USB key of entire final closeout documents including As-builts CAD files and PDFs and two (2) hard copy sets of entire close-out documents including As-builts drawing to Client office. *GC/Subcontractor is responsible for producing the CAD As-built Drawings**

1.55 Liability

- .1 Each Section and Trade shall:
 - .1 Assume full responsibility for laying out his work and for any damage caused to other Sections or Owner by improper location or carrying out of same.
 - .2 Be responsible for prompt installation of work in advance of concrete pouring, ceiling installation or similar work.
 - .3 Protect finished and unfinished work of this Division and work of other Sections from damage due to work of this Division.
 - .4 Be responsible for condition of material and equipment supplied. Be responsible for protection and maintenance of work completed until termination and acceptance.

PART 2 - PRODUCTS

2.1 Materials

- .1 Not used

PART 3 - EXECUTION

3.1 Painting Repairs & Restoration

- .1 Prime and touch up marred finished paintwork to match original.
- .2 Restore to new condition, finishes which have been damaged.

3.2 Cleaning

- .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork

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and air handling units.

3.3 Demonstration

- .1 Consultant will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.

3.4 Protection

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.



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Transfer of Files on Electronic Media

Consultant of Record ("Consultant"): EXP Services Inc.

Contractor ("Contractor"): _____

Re: Project Name, Project Address, ("Owner"): _____

The Contractor hereby acknowledges requesting from the Consultant, electronic data containing graphic (electronic) representation of Engineering Drawings as per attached list of drawings, subject to the condition that the said drawings are to be used only for information and reference in connections with the Owner's use and occupancy of the Project. The Contractor shall be responsible for checking and verifying all dimensions and details, or quantities of materials and for the co-ordination of architectural, structural, mechanical and electrical elements as required to facilitate complete and accurate fabrication and installation. Any omissions and discrepancies shall be reported to the Consultant. The Contractor hereby warrants to the Consultant that the drawings will only be used for development of shop drawings/record drawings. The drawings shall not be used for any other project **or purpose** either by the Contractor or others. The Contractor further warrants not to alter the electronic data or the information contained therein, in any way except for the above noted purposes, and acknowledges that such unauthorized use or alteration of the original work is protected in accordance with the Copyright Act and subject to penalties prescribed therein.

The Contractor hereby acknowledges that the said electronic data contain information which may be updated or altered at any time by the Consultant, and that it is the responsibility of the Contractor to make themselves aware of these changes, in a timely manner. In the event of a conflict between the drawings issued to the Contractor and the sealed Contract Drawings, the sealed Contract Drawings shall govern.

The Contractor agrees to pay the Consultant **\$1.00, plus Applicable Taxes** for these electronic data. The fees noted are to cover the costs of preparation of the electronic data, and disbursements related to the preparation and shipment/forwarding of the electronic data only. By paying the fees quoted, the Contractor has in no way purchased the drawings or any rights to the drawings or the information contained therein, and the Contractor may only alter the drawings for the purposes noted above.

The electronic files will be provided in AutoCAD format (Version 2000 or more recent). The Consultant makes no representation as to the compatibility of these files with the Contractors hardware or software beyond the specified release of the referenced software.

The Contractor shall, to the fullest extent permitted by law, indemnify, defend and hold harmless the Consultant, and its sub-consultants from all claims, damages, losses, expenses, penalties and liabilities for any kind, including attorney's fees, arising out of, or resulting from the use of the electronic data by the Contractor, or by third party recipients of the electronic data from the Contractor.

The Consultant believes that no licensing or copyright fees are due to others on account of the transfer of the electronic media, but to the extent any are, the Contractor will pay the appropriate fees and hold the Consultant harmless from such claims.

Any purchase order number provided by the Contractor is for Contractor's accounting purposes only. Purchase order terms and conditions are void and are not part of this agreement.

The laws of the Province of Ontario shall govern this agreement.

The conditions and undertakings expressed wherein apply to partners, employees, agents, successors, assigns and legal or other representatives of the Contractor.

Dated at _____ this _____ day of _____, 20 ____.

Authorized Acceptance by Consultant

Signature

Print Name and Title _____

Date _____

By Contractor

Signature

Print Name and Title _____

Date _____

Common Work Results for Mechanical

EQUIPMENT START-UP AND ACCEPTANCE CHECK LIST																				
UNIT: LOCATION: MANUFACTURER: MOTOR MANUFACTURER: MOTOR NAMEPLATE: MODEL NO./TYPE: HORSEPOWER/kW: OVERLOAD HEATER/FUSES:	UNIT # SERIAL # SERIAL #																			
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ACCEPTED BY	OWNER'S REP	DATE																		
ACCEPTED BY	CONSULTANT	DATE																		

END OF SECTION

Basic Mechanical Materials and Methods

PART 1 - GENERAL

1.1 Application

- .1 This Section specifies products, common criteria and characteristics, and methods and execution that are common to one or more mechanical work Sections of the Specification, and it is intended as a supplement to each Section and is to be read accordingly.

1.2 Submittals

- .1 Submit the following for review:
 - .1 shop drawings/product data sheets: submit for:
 - .1 pressure gauges and thermometers;
 - .2 electric motors (submit with equipment they are associated with).
 - .2 **access door locations:** submit white prints of architectural reflected ceiling plan drawings and elevation drawings to indicate proposed access door locations in walls and ceilings in finished areas;
 - .3 **samples:** submit a sample of each proposed type of access door, and samples of materials and any other items as specified in mechanical work Sections of the Specification;
 - .4 **list of equipment nameplates:** submit a list of equipment identification nameplates indicating proposed wording and sizes;
 - .5 **pipe & duct identification:** submit a list of pipe and duct identification colour coding and wording;
 - .6 **valve tag chart:** submit a proposed valve tag chart and a list of proposed valve tag numbering and identification wording;
 - .7 **waste management and reduction plan:** submit a waste management and reduction plan prior to commencing work and as per requirements specified in this Section;
 - .8 **additional submittals:** submit any other submittals specified in this Section or other mechanical work Sections of the Specification;

PART 2 - PRODUCTS

2.1 Pipe Sleeves

- .1 Galvanized Sheet Steel: Minimum #16 gauge galvanized steel with an integral flange at one end to secure the sleeve to formwork construction.
- .2 Polyethylene: Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses.
- .3 Galvanized Steel Pipe – Waterproof: Schedule 40 mild galvanized steel pipe with a welded-on square steel anchor and water stop plate at the sleeve midpoint.

Basic Mechanical Materials and Methods

- .4 Galvanized Steel or Cast-Iron Pipe: Schedule 40 mild galvanized steel, or Class 4000 cast iron.

2.2 Fire Stopping and Smoke Seal Materials

- .1 Design firestopping and smoke seals to maintain fire rating required in fire-rated walls and partitions; in all cavity wall construction at each floor level; in expansion joints where fire rating and/or fire separation is required; and elsewhere indicated.
- .2 Provide firestopping system in all joints, cut-outs around penetrations in the walls and floors and elsewhere required to ensure complete integrity of the fire rating prior to start of construction.
- .3 Provide seals to form draft tight barriers to retard the passage of flame, smoke, gas and firefighter's hose stream.
- .4 The installed seal shall provide and maintain a fire-resistance rating equivalent to the rating of the adjacent floor, wall or other fire separation assembly to the requirements and approval of authorities having jurisdiction.
- .5 Firestopping and smoke seals shall be ULC or Intertek Testing Services listed Products and systems in accordance with ULC-S115 suitable to actual application and installation conditions.
- .6 Firestop sealant: single component, low modulus, silicone rubber, moisture curing, ULC labelled to ULC-S115.
- .7 Firestop insulation: to CAN/ULC-S702, Type 2; mineral fibre manufactured from rock or slag, suitable for manual application.
- .8 Density: 81 kg/m³ when tested to ASTM C303.
- .9 Combustibility: Non-combustible to CAN/ULC S114.
- .10 Melt temperature: >1175 degrees C.
- .11 Surface burning characteristics: to CAN/ULC S102, maximum flame spread of 0, smoke developed of 0.
- .12 Moisture Absorption: 0.04 percent when tested to ASTM C1104.
- .13 Smoulder Resistance: 0.01 percent when tested to CAN/ULC S129.
- .14 Damming, back-up, supports, and anchorage: In accordance with manufacturer's fire rated systems and to acceptance of authorities having jurisdiction.
- .15 Primer: As recommended by firestop sealant manufacturer.
- .16 Firestopping and smoke seals shall be ULC or Intertek Testing Services listed Products and systems in accordance with ULC-S115 suitable to actual application and installation conditions. All fire and smoke seals shall be 'L' rating.
- .17 Acceptable fire stop and smoke seal material manufacturers are 3M Canada Inc., Specified Technologies Inc. and A/D Fire Protection Systems and Hilti Canada.

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2.3 Piping Hangers and Supports

- .1 General: Pipe hanger and support materials, including accessories, are to be, unless otherwise specified, in accordance with the Manufacturers Standardization Society (MSS) Standard Practice Manual SP-58, Pipe hangers and Supports-Materials, Design and Manufacture, and where possible, MSS designations are indicated with each product specified below. Conform to the following requirements:
 - .1 unless otherwise specified, all ferrous hanger and support products are to be electro-galvanized;
 - .2 hangers and supports for insulated piping are to be sized to fit around the insulation and the insulation jacket.
- .2 Horizontal Suspended Piping: Hangers and supports are to be:
 - .1 adjustable steel clevis hanger – Anvil Fig. 260 – MSS Type 1;
 - .2 adjustable swivel ring band type hanger – Anvil Fig. 69 – MSS Type 10;
- .3 Horizontal Pipe On Vertical Surfaces: Epoxy coated steel pipe stays are not permitted. Supports are to be:
 - .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
 - .2 heavy-duty steel pipe bracket – Anvil Fig. 262 or Myatt Fig. 161 – MSS Type 26;
 - .3 single steel pipe hook - Myatt Fig. 156;
- .4 Floor Supports For Vertical Risers: Supports are to be:
 - .1 copper tubing riser clamp – Anvil Fig. CT-121, Anvil Fig. CT-121C (plastic coated), or Myatt Fig. 150CT – MSS Type 8;
 - .2 heavy-duty steel riser clamp – Anvil Fig. 261, or Myatt Fig's. 182, 183, 190 and 191 – MSS Type 8.
- .5 Vertical Piping on Vertical Surfaces: Epoxy coated steel pipe stays are not permitted. Supports are to be:
 - .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
 - .2 heavy-duty steel pipe bracket or soil pipe bracket – Anvil Fig. 262 or Myatt Fig. 161 – MSS Type 26;
 - .3 extension split pipe clamp – Anvil Fig's. 138R or Myatt Fig. 129 – MSS Type 12;
- .6 Base of Vertical Risers: Support for vertical risers in excess of 20' (6 m) high extending out from base mounted equipment is to consist of a base elbow support with flange equal to Empire Tool & Mfg. Co. Fig. 830.
- .7 Horizontal Pipe On Racks: Unistrut or equal galvanized steel pipe racks with pipe securing hardware as follows:
 - .1 standard galvanized steel U-bolts/clamps supplied by the rack manufacturer;
- .8 Special Hangers and Supports: Special hangers and supports for various applications are as follows:

Basic Mechanical Materials and Methods

- .1 **vibration isolated riser supports** – black steel riser clamps as specified above, complete with neoprene–steel–neoprene sandwich type vibration isolation pads between the clamp and the floor;
- .2 **for groups of pipes having the same slope** – Anvil Fig. 195 welded steel brackets, Anvil Fig. 46 universal trapeze assemblies, or Unistrut or equal support assemblies, all with U-bolts, clamps, etc., to secure pipes in place;
- .3 **for sections of piping connected to vibration isolated equipment** – hangers and supports as specified above but complete with MSS Type 48 spring cushions;
- .4 **for plastic piping** – generally as specified above but in accordance with the pipe manufacturer's printed recommendations;
- .5 **for fire protection piping** – generally as above but ULC listed and/or FM approved, and in accordance with Chapter requirements of the NFPA Standard applicable to the piping system;
- .6 **for bare horizontal copper piping** – generally as above but factory vinyl coated to prevent direct copper/steel contact;
- .7 **for bare copper vertical piping** – corrosion resistant ferrous clamps with flexible rubber gasket type material (not tape) to isolate the pipe from the clamp;
- .8 **insulation protection shields to & including 1½" dia.** – equal to Anvil "Rib-Lok" Fig. 168 galvanized steel shields with ribs to keep the shield centred on the hanger.
- .9 Hanger Rods: Electro-galvanized carbon steel (unless otherwise specified), round, threaded, to ASTM A36, complete with captive machine nuts with washers at hangers, sized to suit the loading in accordance with Table 3 in MSS SP-58, but in any case, minimum 3/8" diameter.
- .10 Acceptable Manufacturers: Acceptable hanger and support material manufacturers are:
 - .1 E. Myatt & Co. Inc.;
 - .2 Anvil International Inc.;
 - .3 Empire Tool & Mfg. Co. Inc.;
 - .4 Hunt Manufacturing Ltd.;
 - .5 Unistrut Canada Ltd.;
 - .6 Nibco Inc. "Tolco";
 - .7 Taylor Pipe Supports.

2.4 Access Doors

- .1 Prime coat painted steel (unless otherwise specified) flush access doors, each complete with a minimum #16 gauge frame, minimum #18 gauge door panel, heavy-duty rust-resistant concealed hinges, a positive locking screwdriver lock, and mounting and finishing features to suit the particular construction in which it is to be installed.

Basic Mechanical Materials and Methods

- .2 Access door sizes are to suit the concealed work for which they are supplied, and wherever possible they are to be of a standard size for all applications, but in any case, they are to be minimum 12" x 12" for hand entry and 24" x 24" for body entry.
- .3 Access doors in fire rated construction are to be ULC listed and labelled and of a rating to maintain the fire separation integrity.
- .4 Where access doors are located in surfaces where special finishes are required, they are to be of a recessed door type capable of accepting the finish in which they are to be installed so as to maintain the final building surface appearance throughout and constructed of stainless steel with a #4 finish.

2.5 Mechanical Work Identification Materials

- .1 Equipment Nameplates: Minimum 1/16" thick 2-ply laminated coloured plastic plates, minimum 1/2" x 2" for smaller items such as damper motors and control valves, minimum 1" x 2 1/2" for equipment, and minimum 2" x 4" for control panels and similar items. Additional requirements are as follows:
 - .1 unless otherwise specified or required, each nameplate is to be white, complete with bevelled edges and black engraved wording to completely identify the equipment and its use with no abbreviations;
 - .1 wording is generally to be as per the drawings or UHN equipment naming convention, i.e. Fan 5-P-104, and is to include equipment service and building area/zone served, but must be reviewed prior to engraving;
 - .2 supply stainless steel screws for securing nameplates in place;
 - .3 nameplates for equipment suspended above floor level or generally not within easy viewing from floor level are to be increased in size so as to be easily readable from floor level.
- .2 Valve Tags: Coloured, 1 1/2" square, 2-ply laminated plastic with bevelled edges, red-white, green-white, yellow-black, etc., to match the piping identification colour, each complete with a 1/8" diameter by 4" long brass plated steel bead chain, and four lines of engraved maximum size identification wording, i.e.:
 - .1 Valve V12
 - .2 8"
 - .3 Normally Open
- .3 Standard Pipe Identification: Standard pipe identification is to be in accordance with latest ANSI/ASME A13.1 "Scheme for the Identification of Piping Systems", equal to Smillie McAdams Summerlin Ltd. or Brady vinyl plastic with indoor/outdoor type vinyl ink lettering and directional arrows, as follows:
 - .1 for pipe to and including 6" diameter, coiled type snap-on markers of a length to wrap completely around the pipe or pipe insulation;
 - .2 for pipe larger than 6" diameter, saddle type strap-on markers with 2 opposite identification locations and complete with nylon cable ties.
- .4 Standard Pipe Identification Wording and Colours: Identification wording and colours for

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pipe identification materials are to be as follows:

PIPE SERVICE	IDENTIFICATION COLOUR	LEGEND
domestic cold water	green	DOM. COLD WATER
domestic hot water supply	green	DOM. HW SUPPLY
domestic hot water recirculation	green	DOM. HW RECIRC.
sanitary drainage	green	SAN.
plumbing vent	green	SAN. VENT
fire protection standpipe	red	F.P. STANDPIPE
fire protection sprinklers	red	F.P. SPRINKLER
heating water supply	yellow	HTG. WTR. SUPPLY
heating water return	yellow	HTG. WTR. RETURN

- .5 Colours For Legends & Arrows: Colours for pipe identification legends and directional arrows are to be as follows:

IDENTIFICATION COLOUR	LEGEND & ARROW COLOUR
red	white
orange	black
yellow	black
brown	white
green	white
blue	white

- .6 Duct Identification: Custom made Mylar stencils with 2" high lettering to accurately describe the duct service, i.e. "AHU-1 SUPPLY", complete with a directional arrow, and coloured ink with ink pads and roller applicators. Ink colour is generally to be black but must contrast with the lettering background.

2.6 Flexible Connectors

- .1 Double wall stainless steel flexible connectors for piping connections to vibration isolated equipment, each selected by the manufacturer to suit the application. Shop drawings or product data sheets must indicate construction and performance requirements that suit the application. Acceptable manufacturers are:
- .1 Hyspan Precision Products Inc.;
 - .2 Senior Flexonics Ltd.;

Basic Mechanical Materials and Methods

.3 The Metraflex Co.

PART 3 - EXECUTION

3.1 General Piping and Ductwork Installation Requirements

- .1 Unless otherwise specified, locate and arrange horizontal pipes and ducts above or at the ceiling on floors on which they are shown, arranged so that under consideration of all other work in the area, the maximum ceiling height and/or usable space is maintained. If required to maintain ceiling heights, reroute and/or resize ductwork, with Consultant's approval.
- .2 Unless otherwise specified, install all work concealed in finished spaces, and concealed to the degree possible in partially finished and unfinished spaces. Refer to and examine the Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas. Note that walls which are painted are considered finished.
- .3 Install all pipes and ducts parallel to building lines and to each other.
- .4 Neatly group and arrange all exposed work.
- .5 Service and Maintenance Access: Locate all work to permit easy access for service or maintenance as required and/or applicable. Locate all valves, dampers and any other equipment which will or may need maintenance or repairs and which are installed in accessible construction so as to be easily accessible from access doors. Where valves, dampers and similar piping or ductwork accessories occur in vertical services in shafts, pipe spaces or partitions, locate the accessories at the floor level.
- .6 Dissimilar Metal Pipe Connections: Make all connections between pipes of different materials using proper approved adapters. Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe.
- .7 Manufacturer's Instructions: Ensure that equipment and material manufacturer's installation instructions are followed unless otherwise specified herein or on the drawings, and unless such instructions contradict governing codes and regulations.
- .8 Cleaning: Carefully clean all ducts, pipe and fittings prior to installation. Temporarily cap or plug ends of pipe, ducts and equipment which are open and exposed during construction.
- .9 Insulation Clearance: Install piping and ductwork which are to be insulated so that they have sufficient clearance to permit insulation and finish to be applied continuously and unbroken around the pipe or duct, except for ductwork at fire barriers, in which case the insulation will be terminated at each side of the duct fire damper.
- .10 Surfaces To Receive Your Work: Inspect surfaces and structure prepared by other trades before performing your work. Verify that surfaces or the structure to receive your work have no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing. Installation of your work will constitute acceptance of such surfaces as being satisfactory.
- .11 Piping Rust and Dirt: Any ferrous piping that exhibits in excess of 5% surface rust, either inside or outside or both is to be wire brush cleaned to bare metal and coated with

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suitable primer. Steel pipe, fittings and accessories are to be free of corrosion and dirt when work is complete or prior to being concealed from view. Where dirt is evident, clean the piping prior to being concealed.

- .12 Repair of Finished Surfaces: For factory applied finishes, repaint or refinish all surfaces damaged during shipment and installation. The quality of the repair work is to match the original finish. This requirement also applies to galvanized finishes.
- .13 Unions and Flanges: Whether shown or specified on the drawings or not, provide screwed unions or flanges in all piping connections to equipment, and in regular intervals in long (in excess of 12 m/40') piping runs to permit removal of sections of piping.
- .14 Elbows and Eccentric Reducers: Unless otherwise specified and except where space limitations do not permit, all piping elbows are to be long radius. Eccentric reducers are to be installed with the straight side at the top of the piping.

3.2 Pipe Joint Requirements

- .1 Do not make pipe joints in walls or slabs.
- .2 Ream all piping ends prior to making joints.
- .3 Screwed Steel Piping: Properly cut threads in screwed steel piping and coat male threads only with Teflon tape or paste, or an equivalent thread lubricant. After the pipe has been screwed into the fitting, valve, union, or piping accessory, not more than two pipe threads are to remain exposed.
- .4 Welded Steel Piping: Site bevel steel pipe to be welded or supply mill bevelled pipe. Remove all scale and oxide from the bevels and leave smooth and clean. Use factory made welding tees or welding outlet fittings for piping branches off mains. Do not use shop or site fabricated fittings unless written approval has been obtained.
- .5 Welding Requirements: Welded joints are to be made by CWB certified, licensed journeyman welders qualified in accordance with CSA B51, Boiler Pressure Vessel and Pressure Piping Code, and who are in possession of a proper certificate of qualification for each procedure to be performed. Each weld is to be identified with the welder's identification symbol, and welds are not to be concealed until they have been inspected and approved. Electrodes are to be in accordance with CSA W48 Series, Electrodes, and requirements of CAN/CSA W117.2, Safety in Welding, Cutting and Allied Processes are to be followed.
- .6 Flanged Joints: Unless otherwise specified, make all flanged joints with Cranite Ltd. or equivalent gasket materials to suit the application, and bolts and nuts. Bolts are not to be longer than the length necessary to screw the nut up flush to the end of the bolt. Bolts used for flanged connections in all piping with a working pressure of 100 psi and greater are to be ASTM A-193, Grade B-7, with heavy hexagon nuts to ASTM A-194, CL-2H. Provide suitable washers between each bolt head and the flange and between each nut and the flange.
- .7 Examination of Flanged Joints: A random check of bolted flanged connections will be made to verify that flanged connections are properly mated with no shear force acting on bolts. Supply all labour to disconnect and reconnect the selected flanged joints. If improperly mated joints are found, remove and reinstall the affected piping so that the

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flanges mate properly. If improperly mated joints are found, additional joints will be checked, and you will be responsible for the repair of any other improper joints discovered.

- .8 Soldered Joints: Unless otherwise specified make all soldered joints in copper piping using flux suitable for and compatible with the type of solder being used. Clean the outside of the pipe end and the inside of the fitting, valve, or similar accessory prior to soldering.
- .9 Mechanical Joints: Install mechanical joint fittings and couplings in accordance with the manufacturer's instructions.
- .10 Grooved Pipe & Coupling Joints: Grooves are to be rolled. Make arrangements with the coupling and fitting manufacturer for shop and/or site instructions and demonstrations as required, and adhere to the manufacturer's instructions with respect to pipe grooving, support, type of gasket required, anchoring and guiding the grooved piping system.
- .11 Pressure Crimped Piping Joints: If pressure crimped couplings and fittings are used, ensure that gaskets are fully compatible with the piping fluid, and that all valves and piping accessories are suitable. Use only fitting manufacturer supplied crimping equipment. Comply with the manufacturer's latest published specification, instructions, and recommendations with respect to pipe, coupling, and fitting preparation and installation, and support, anchoring and guiding of the piping system.
- .12 PVC Piping Solvent Weld Joints: Solvent weld PVC piping in two parts, primer stage and cementing stage, in accordance with the manufacturer's recommendations, ASTM D2855, and CSA requirements.
- .13 PVC Piping Gasketed Joints: Install PVC piping with gasketed joints in accordance with the manufacturer's current published specifications, instructions and recommendations, and CSA requirements.

3.3 Installation of Pipe Sleeves

- .1 Where pipes pass through concrete and/or masonry surfaces provide pipe sleeves as follows:
 - .1 in poured concrete slabs: unless otherwise specified - minimum 16 gauge flanged galvanized steel or, where permitted by governing authorities, factory fabricated plastic sleeves;
 - .2 in concrete or masonry walls: Schedule 40 galvanized steel pipe or Class 4000 cast iron pipe.
- .2 Waterproof Sleeves: Sleeves in waterproofed slabs or walls are to be lengths of Schedule 40 mild galvanized steel pipe with a waterstop plate in accordance with the drawing detail. Provide waterproof sleeves in the following locations:
 - .1 in mechanical room floor slabs, except where on grade;
 - .2 in slabs over mechanical, fan, electrical and telephone equipment rooms or closets;
 - .3 in all floors equipped with waterproof membranes;

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- .4 in the roof slab;
- .5 in waterproof walls.
- .3 Size sleeves, unless otherwise specified, to leave ½" clearance around the pipes, or where the pipe is insulated, a ½" clearance around the pipe insulation.
- .4 Pack and seal the void between the pipe sleeves and the pipe or pipe insulation in non-fire rated construction for the length of the sleeves as follows:
 - .1 interior construction: pack sleeves in interior construction with mineral wool and seal both ends of the sleeves with non-hardening silicone base caulking compound;
 - .2 exterior walls above grade: pack sleeves in exterior walls above grade with mineral wool and seal both ends of the sleeves water-tight with approved non-hardening silicone base caulking compound unless mechanical type seals have been specified;
- .5 Where sleeves are required in masonry work, accurately locate and mark the sleeve location, and hand the sleeves to the mason for installation.
- .6 Terminate piping for sleeves that will be exposed so that the sleeve is flush at both ends with the building surface concerned so that the sleeve may be completely covered by an escutcheon plate, except for sleeves in waterproof floors which are to terminate 4" above the finished floor.
- .7 "Gang" type sleeving will not be permitted.
- .8 Where piping has been removed from existing sleeves, cap and seal both ends of the sleeved opening.

3.4 Installation of Waterproof Mechanical Seals

- .1 Provide watertight link type mechanical seals in exterior wall openings where shown or specified.
- .2 Assemble and install each mechanical seal in accordance with the manufacturer's instructions.
- .3 After installation, periodically check each mechanical seal installation for leakage and, if necessary, tighten link seal bolts until the seal is completely watertight.

3.5 Duct Openings

- .1 Duct openings, air inlet and outlet openings, fire damper and similar openings will be provided in new poured concrete work, masonry, drywall and other building surfaces by the trade responsible for the particular construction in which the opening is required.
- .2 Ensure that openings for fire dampers to 24" high are sized to suit the damper arrangement with the folding blade out of the air stream.
- .3 For all duct openings except where fire dampers are required, pack and seal the space between the duct or duct insulation and the duct opening as specified above for pipe openings in non-fire rated construction.

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3.6 Sleeve and Formed Opening Location Drawings

- .1 Prepare and submit for review, white print drawings indicating the size and location of all required sleeves, recesses and formed openings in poured or precast concrete work.
- .2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs
- .3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

3.7 Installation of Pipe Escutcheon Plates

- .1 Provide escutcheon plates suitable secured over all exposed piping passing through finished building surfaces. A finished building surface is any surface with a factory finish or that receives a site applied finish.
- .2 Install the plates so that they are tight against the building surface concerned and ensure that the plates completely cover pipe sleeves and/or openings, except where waterproof sleeves extend above floors, in which case the plate is to fit tightly around the sleeve.

3.8 Installation of Fastening and Securing Hardware

- .1 Provide all fastening and securing hardware required for mechanical work to maintain installations attached to the structure or to finished floors, walls and ceilings in a secure and rigid manner capable of withstanding the dead loads, live loads, superimposed dead loads, and any vibration of the installed products.
- .2 Use fasteners compatible with structural requirements, finishes and types of products to be connected. Do not use materials subject to electrolytic action or corrosion where conditions are liable to cause such action.
- .3 Where the floor, wall or ceiling construction is not suitable to support the loads, provide additional framing or special fasteners to ensure proper securement to the structure that is to support the products. Provide reinforcing or connecting supports where required to distribute the loading to the structural components.
- .4 Obtain written consent before using explosive actuated fastening devices. If consent is obtained, comply with requirements of CSA Standards CAN3-Z166.1 and CAN3-Z166.2.
- .5 Do not attach fasteners to steel deck without written consent from the Consultant.

3.9 Installation of Pipe Hangers and Supports

- .1 Provide all required pipe hangers and supports.
- .2 Provide any additional structural steel channels, angles, inserts, beam champs and similar accessories required for hanging or supporting pipe. Unless otherwise shown or specified, hang or support pipes from the structure only.
- .3 For Insulated Pipe: Size the hanger or support to suit the diameter of the insulated pipe and install the hanger or support on the outside of the insulation and insulation finish.

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- .4 Horizontal Above Ground Piping: Unless otherwise shown or specified, hang and/or support horizontal pipe above ground by means of hangers and/or supports specified in Part 2 of this Section. Unless otherwise shown or specified, hangers for suspended pipe to and including 1" dia. are to be clevis type or adjustable ring type, and hangers for suspended pipe 1½" dia. and larger are to be adjustable clevis type. Space hangers and supports in accordance with the following:

- .1 cast iron pipe: hang or support at every joint with maximum 8' spacing;
- .2 plastic pipe: conform to pipe manufacturer's recommended support spacing;
- .3 glass pipe: conform to pipe manufacturer's recommended support spacing and support requirements;
- .4 copper and steel pipe: hang or support at spacing in accordance with the following schedule:

PIPE DIA.	MAX. SPACING STEEL (meters)	MAX. SPACING COPPER (meters)
to 1"	2.4 (8')	1.8 (6')
1½"	2.7 (9')	2.4 (8')
2"	3.0 (10')	2.7 (9')
2½"	3.6 (12')	3.0 (10')
3"	3.6 (12')	3.0 (10')
3½"	3.6 (12')	3.6 (12')
4"	4.2 (14')	3.6 (12')
10"	6.0 (20')	
12"	6.6 (22')	

- .5 flexible grooved pipe/coupling joint piping: as above but with not less than one hanger or support between joints;
- .6 changes in direction: where pipes change direction, either horizontally or vertically, provide a hanger or support on the horizontal pipe not more than 12" from the elbow, and where pipes drop from tee branches, support the tees in both directions not more than 2" on each side of the tee;
- .7 grouped piping: when pipes with the same slope are grouped and a common hanger or support is used, space the hanger or support to suit the spacing requirement of the smallest pipe in the group and secure pipes in place on the common hanger or support;
- .8 roller hangers & supports: provide roller hangers or supports for all heat transfer piping 8" diameter and larger and conveying a material 75°C (170°F) or greater to facilitate pipe movement due to expansion and contraction, and at each hanger or support tack weld a steel protection saddle to the pipe to protect the piping insulation.

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- .5 Vertical Piping: Unless otherwise shown or specified, support vertical piping by means of supports specified in Part 2 of this Section, spaced in accordance with the following:
 - .1 support vertical pipes at maximum 3 m intervals or at every floor, whichever is lesser;
 - .2 for sections of vertical piping with a length less than 10', support the pipe at least once;
 - .3 for all vertical cast iron plain end pipe (mechanical joint type), secure the riser or pipe clamp around the pipe under a flange integral with the pipe for vertical support purposes, or provide a length of hub and spigot pipe to facilitate proper support;
 - .4 for all vertical steel pipe risers in excess of 10', weld shear lugs to the pipe to carry the load;
 - .5 for vibration isolated piping risers, provide rubber-steel-rubber vibration isolation pads between the riser clamps and the floor.
- .6 Isolation for Bare Copper Tubing: Each hanger, support or securement for horizontal bare copper tubing is to be plastic coated to prevent direct contact between the pipe and the ferrous hanger. Each wall or floor clamp for vertical bare copper piping is to be isolated from the pipe by means of strips of flexible rubber inserts. The use of painted ferrous hangers and supports, including those painted with copper coloured paint, is not acceptable. Site application of tape or other types of isolation is not acceptable.
- .7 Insulation Protection Shields: For insulated horizontal piping to and including 1½" diameter, provide galvanized steel insulation protection shields between the insulation and the hanger or support. Install shields immediately after the pipe is insulated.
- .8 Pipe Support from Steel Deck: Do not support piping from steel deck without written consent from the Consultant.

3.10 Supply of Access Doors

- .1 Supply access doors to give access to all mechanical work which may need maintenance or repair but which is concealed in inaccessible construction, except as otherwise specified herein or on the drawings.
- .2 Locate access doors as inconspicuously as possible in walls and partitions and arrange mechanical work such that it is clearly within view and accessible for inspection and servicing, and to suit access door locations shown on the reviewed and approved white prints of reflected ceiling plan and elevation drawings submitted as per Part 1 of this Section.
- .3 Group piping and ductwork to ensure the minimum number of access doors is required. Access doors will be installed by the trades responsible for the particular type of construction in which the doors are required.
- .4 Submit a sample of each proposed access door for review prior to ordering.

3.11 Installation of Valves

- .1 Generally, valve locations are indicated or specified on drawings or specified in Sections

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of the Specification where the valves are specified, however, regardless of locations shown or specified, the following requirements apply:

- .1 provide shut-off valves to isolate all systems, at the base of all vertical risers, in branch take-offs at mains and risers on all floors, to isolate all equipment, to permit work phasing as required, and wherever else required for proper system operation and maintenance;
- .1 install shut-off valves with handles upright or horizontal, not inverted, and located for easy access;
- .2 unless otherwise specified, provide a check valve in the discharge piping of each pump;
- .3 valve sizes are to be the same as the connecting pipe size;
- .4 valves are to be permanently identified with the size, manufacturer's name and figure number, and wherever possible, valves are to be the product of the same manufacturer;
- .5 the manufacturer's name, valve model or figure number, and the pressure rating are to be clearly marked on each valve;
- .6 for valves in insulated piping, the design of the valve stem, handle and operating mechanism is to be such that the insulation does not have to be cut or altered in any manner to permit valve operation.

3.12 Mechanical Work Identification

- .1 Exposed Piping & Ductwork: Identify new exposed piping and ductwork as per Part 2 of this Section in locations as follows:
 - .1 at every end of every piping or duct run;
 - .1 adjacent to each valve, strainer, damper and similar accessory;
 - .2 at each piece of connecting equipment;
 - .3 on both sides of every pipe and duct passing through a floor, wall or partition, unless otherwise specified;
 - .4 at 20' (6 m) intervals on pipe and duct runs exceeding 6 m in length;
 - .5 at least once in each room, and at least once on pipe and duct runs less than 20' (6 m) in length.
- .1 Concealed Piping & Ductwork: Unless otherwise specified identify new concealed piping and ductwork as per Part 2 of this Section in locations as follows:
 - .1 at points where pipes or ducts enter and leave rooms, shafts, pipe chases, furred spaces, and similar areas;
 - .2 at maximum 20' intervals on piping and ductwork above suspended accessible ceilings, and at least once in each room;
 - .3 at each access door location;
 - .4 at each piece of connected equipment, automatic valve, etc..

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- .2 Equipment: Provide an identification nameplate for each new piece of equipment, including items such as control valves, motorized dampers, instruments, and similar products. Secure nameplates in place, approximately at eye level if possible, with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces. Locate all nameplates in the most conspicuous and readable location.
- .3 Valve Tagging & Chart: Tag valves and prepare a valve tag chart in accordance with the following requirements:
 - .1 attach a valve tag to each new valve, except for valves located immediately at the equipment they control;
 - .2 prepare a computer printed valve tag chart to list all tagged valves, with, for each valve, the tag number, location, valve size, piping service, and valve attitude (normally open or normally closed);
 - .3 if an existing valve tag chart is available at the site, valve tag numbering is to be an extension of existing numbering and the new valve tag chart is to incorporate the existing chart;
 - .4 frame and glaze one copy of the chart and, unless otherwise directed, affix to a wall in each main Mechanical and/or Equipment Room;
 - .5 include a copy of the valve tag chart in each copy of the operating and maintenance instruction manuals;
 - .6 hand an identified and packaged (jewel case) compact disc of the valve tag chart to the Owner at the time the O & M Manuals are submitted.
- .4 Ceiling Tacks or Stickers: Where new shut-off valves, control dampers, sensors, and similar items which will or may need maintenance and/or repair are located above accessible suspended ceilings, provide round coloured ceiling tacks in the ceiling panel material, or stickers equal to Brady "Quick Dot" on the ceiling grid material to indicate locations of the items. Unless otherwise specified, ceiling tack or sticker colours are to be as follows:
 - .1 HVAC piping valves and equipment: yellow
 - .2 fire protection valves and equipment: red
 - .3 plumbing valves and equipment: green
 - .4 HVAC ductwork dampers and equipment: blue
 - .5 control system hardware and equipment: orange

3.13 Finish Painting of Mechanical Work

- .1 Touch-up paint all damaged factory applied finishes on mechanical work products.

3.14 Pipe Leakage Testing

- .1 Before new piping has been insulated or concealed, and before equipment, fixtures and fittings have been connected, test all piping for leakage.

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- .2 Tests are to be witnessed by the Consultant and/or Owner's representative, and, where required, representatives of governing authorities. Give ample notice of tests in writing and verify attendance. Have completed test report sheets dated and signed by those present to confirm proper test results.
- .3 When circumstances prevent scheduled tests from taking place, give immediate and adequate notice of cancellation to all who were scheduled to attend.
- .4 Gravity Drainage & Vent Piping: Securely close all openings and pipe ends and fill piping with water up to the highest level and ensure that the water stands at the same level for a minimum of two hours. After the fixtures and fittings are set and the pipes connected to the building drain or drains, turn on water into all pipe, fixtures, fittings and traps in order to detect any imperfect material or workmanship. Make a smoke test if required by the Municipality. At your option, drain and vent piping may be pressure tested with cold water at 50 psi (345 kPa) for two hours with zero leakage.
- .5 Pumped Drainage Piping: Test piping with cold water at a pressure of 1½ times normal working pressure and maintain the pressure for a minimum of two hours.
- .6 Domestic Water Piping: Test piping with cold water at a pressure of 1½ times normal working pressure and maintain the pressure for a minimum of two hours.
- .7 Sprinkler System Piping: Test all system piping in accordance with requirements of NFPA No. 13, "INSTALLATION OF SPRINKLER SYSTEMS", and in accordance with any additional requirements of governing authorities.
- .8 Standpipe System Piping: Test all system piping in accordance with requirements of NFPA No. 14, "STANDPIPE AND HOSE SYSTEMS", and in accordance with any additional requirements of governing authorities.
- .9 Heat Transfer (HVAC) System Piping: Test piping with cold water at a pressure of 150 psi (1035 kPa) for a minimum of two hours.
- .10 Steam & Condensate Piping: Test piping with cold water for a minimum of two hours at the following pressures:
 - .1 0 psi to 15 psi low pressure piping - 100 psi;
 - .2 16 psi to 99 psi medium pressure piping - 150 psi;
 - .3 greater than 99 psi high pressure piping - 200 psi.
- .11 Compressed Air Piping: Test piping with dry compressed air or nitrogen 100 psi for a minimum of two hours. Test all piping joints with a water-soap solution while the piping is under pressure to detect leaks.
- .12 Refrigerant Piping: Test refrigerant piping for leakage and dehydrate in accordance with requirements of Chapter 18 of the ASHRAE HANDBOOK - FUNDAMENTALS.
- .13 Medical Gas System Piping: Perform leakage and flow tests for all piping using oil-free compressed air or oil-free dry nitrogen in accordance with requirements of CAN/CSA Standard Z7396.1.
- .14 General Re: All Testing: The following requirements apply to all testing:
 - .1 ensure that all piping has been properly flushed, cleaned and is clear of foreign

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- matter prior to pressure testing;
- .2 temporarily remove or valve off all piping system specialties or equipment which may be damaged by test pressures prior to pressure testing the systems, and flush piping to remove foreign matter;
- .3 when testing is carried out below the highest level of the particular system, increase the test pressure by the hydrostatic head of 1 psi for every 24" below the high point;
- .4 include for temporary piping connections required to properly complete the tests;
- .5 piping under test pressure is to have zero pressure drop for the length of the test period;
- .6 make tight leaks found during tests while the piping is under pressure, and if this is impossible, remove and refit the piping and reapply the test until satisfactory results are obtained;
- .7 where leaks occur in threaded joints in steel piping, no caulking of these joints will be allowed under any conditions;
- .8 tests are to be done in reasonably sized sections so as to minimize the number of tests required;
- .9 in addition to the leakage tests specified above, demonstrate proper flow throughout the systems including mains, connections and equipment, as well as proper venting and drainage, and Include for any necessary system adjustments to achieve the proper conditions.

3.15 Interruption to and Shut-Down Of Mechanical Services and Systems

- .1 Co-ordinate all shut-down and interruption to existing mechanical systems with the Owner. Generally, shut-downs may be performed only between the hours of 12:00 midnight Friday until 6:00 a.m. Monday morning.
- .1 Upon award of a Contract, submit a list of anticipated shut-down times and their maximum duration.
- .2 Prior to each shut-down or interruption, inform the Owner and Consultant in writing 15 days in advance of the proposed shut-down or interruption and obtain written approval to proceed. Do not shut-down or interrupt any system or service without such written approval.
- .3 Perform work associated with shut-downs and interruptions as continuous operations to minimize the shut-down time and to reinstate the systems as soon as possible, and, prior to any shut-down, ensure that all materials and labour required to complete the work for which the shut-down is required are available at the site.
- .1 In general, where demolition will cause shutdown of services to areas which are to remain functional, it is expected that new work is to be roughed-in up to the point of final connections in order to minimize shutdowns. In many cases, this will require the need to run new services parallel to the existing services which are to be removed.

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- .4 Pipe Freezing: Pipe freezing may be used to connect new piping to existing piping without draining the existing piping. Pipe freeze equipment is to be equal to "NORDIC FREEZE" equipment supplied by Mag Tool Inc. (1-800-661-9983).
 - .1 Note that due to the age of some of the services within the existing buildings, shut-off valves may be seized or will not hold. Where connecting to existing hydronic piping, it is to be assumed that pipe freezing will be required.

3.16 Cutting, Drilling, and Patching for Mechanical Work

- .1 Do all cutting, drilling and patching of the existing building for the installation of your work. Perform all cutting and drilling with proper tools and equipment. Confirm the exact location of cutting and drilling with the Consultant prior to commencing the cutting and/or drilling work.
 - .1 This includes for all required mechanical work, inclusive of areas outside of the defined renovation and scope of work areas indicated on the architectural drawings.
- .1 Patch surfaces, where required, to exactly match existing finishes using tradesmen skilled in the particular trade or application worked on.
- .2 Where new pipes pass through existing construction, core drill an opening. Size openings to leave ½" clearance around the pipes or pipe insulation.
- .3 Prior to drilling or cutting an opening in poured concrete construction, determine the location, if any, of existing services concealed in the construction to be drilled or cut. Ferro Scan Test the walls or slabs if required.
- .4 You will be responsible for the repair of any damage to existing services, exposed or concealed, caused as a result of your cutting or drilling work.

3.17 Packing and Sealing Core Drilled Pipe Openings

- .1 Pack and seal the void between the pipe opening and the pipe or pipe insulation for the length of the opening as follows:
 - .1 non-fire rated interior construction: pack openings in non-fire rated interior construction with mineral wool and seal both ends of the opening with non-hardening silicone base caulking compound to produce a water-tight seal;

3.18 Cleaning Mechanical Work

- .1 Refer to cleaning requirements specified in Division 01.
- .1 Clean all mechanical work prior to application for Substantial Performance of the Work.
- .2 Include for vacuum cleaning the interior of air handling units and ductwork systems.

3.19 Maintaining Equipment Prior to Acceptance

- .1 Maintain all equipment in accordance with the manufacturer's printed instructions prior to start-up, testing and commissioning.
- .2 Employ a qualified millwright to check and align shafts, drives, and couplings on all base

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mounted split coupled motor driven equipment.

- .3 Where equipment lubrication fittings are not easily accessible, extend the fittings to accessible locations using copper or aluminium tubing.
- .4 All filters are to be new upon Substantial Performance of the work. This is in addition to any spare filters specified.

3.20 Connections to Other Equipment

- .1 Carefully examine the Contract Documents during the bidding period and include for mechanical work piping and/or ductwork connections to equipment requiring such connections.

3.21 Waste Management and Disposal

- .1 Separate and recycle waste materials in accordance with requirements specified in Division 01.

3.22 Installation of Flexible Connectors

- .1 Provide flexible connectors in piping connections to all seismically restrained equipment, and wherever else shown.
- .1 Provide flexible connectors in all piping connections to vibration isolated equipment.

3.23 Fire Stopping

- .1 Ensure that fire ratings of floors and walls are maintained.
- .2 Fill spaces between openings, pipes and ducts passing through fire separations and install firestopping systems in accordance with the appropriate ULC system number for the products and type of penetration.
- .3 Install firestopping systems using personnel trained or instructed by the product manufacturer.

END OF SECTION

Mechanical Insulation

PART 1 - GENERAL

1.1 Application

- .1 This Section specifies insulation requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.2 Submittals

- .1 **Insulation System Samples:** At least four weeks prior to insulation work commencing, submit a sample of each type of insulation (and insulation accessories and finish), in applied form, for approval. Mount the samples on a plywood board. Identify each product with the manufacturer's name and insulation type, and the proposed use of the insulation. When the sample board has been approved, all mechanical insulation work is to conform to the approved sample board.
- .2 **Product Data Sheets:** Submit a product data sheet for each insulation system product.
- .3 **Removable/Reusable Insulation Covers:** Submit a fabrication drawing for each custom made cover to indicate material and fabrication details, and a 300 mm (12") square sample of the proposed cover material.
- .4 **Fire Rated Duct Wrap Certification Letter:** As per Part 3 of this Section, submit a letter from the fire rated duct wrap supplier to certify that the duct wrap has been properly installed.
- .5 **Lagging Adhesive Colour Samples:** Submit a colour chart for coloured lagging adhesive for canvas jacketed insulation.

1.3 Quality Assurance

- .1 Mechanical insulation is to be applied by a licensed journeyman insulation mechanic, or by an apprentice under direct, daily, on-site supervision of a journeyman mechanic.
- .2 Do not apply insulation unless leakage tests have been satisfactorily completed.
- .3 Ensure that all surfaces to be insulated are clean and dry.
- .4 Ensure that the ambient temperature is minimum 13°C (55°F) for at least one day prior to the application of insulation, and for the duration of insulation work, and that relative humidity is and will be at a level such that mildew will not form on insulation materials.
- .5 The company with the sub-contract for mechanical insulation work is to be a member in good standing of the Thermal Insulation Association of Canada.
- .6 All insulation materials must be stored on site in a proper and dry storage area. Any wet insulation material is to be removed from the site.

1.4 Definitions

- .1 For the work of this Section:

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- .1 "concealed" means mechanical services and equipment above suspended ceilings, in non-accessible chases, in accessible pipe spaces, and furred-in spaces;
- .2 "exposed" means exposed to normal view during normal conditions and operations;
- .3 "mineral fibre" includes glass fibre, rock wool, and slag wool;
- .4 "domestic water" or "potable water" means all piping extended from the building Municipal supply main.

PART 2 - PRODUCTS

2.1 Fire Hazard Ratings

- .1 Unless otherwise specified, all insulation system materials inside the building must have a fire hazard rating of not more than 25 for flame spread and 50 for smoke developed when tested in accordance with CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.

2.2 Thermal Performance

- .1 Unless otherwise specified, thermal performance of insulation is to meet or exceed the values given in Tables 6.8.2.A, 6.8.2.B, 6.8.3.A and 6.8.3.B of ASHRAE/IES Standard 90.1.

2.3 Pipe Insulation Materials

- .1 **Horizontal Pipe Insulation at Hangers & Supports:** Equal to Belform Insulation Ltd. "Koolphen K-Block" insulated pipe support inserts consisting of minimum 150 mm (6") long, premoulded, rigid, sectional phenolic foam insulation (of same thickness as adjoining insulation) with a reinforced foil and kraft paper vapour barrier jacket and a captive galvanized steel saddle.
- .2 **Flexible Foam Elastomeric:** Closed cell, sleeve type, longitudinally split self-seal, foamed plastic pipe insulation with a water vapour transmission rating of 0.10 in accordance with ASTM E96-90, Procedure B, and all required installation accessories. Acceptable products are:
 - .1 Armacell AP/Armaflex SS;
 - .2 IK Insulation Group K-Flex "LS" Self-Seal Pipe Insulation.
- .3 **Premoulded Mineral Wool:** Rigid, sectional, sleeve type, non-combustible, longitudinally split mineral wool or basalt pipe insulation with a reinforced vapour barrier jacket. Acceptable products are:
 - .1 ProRox PS 960;
 - .2 IIG (Johns Manville Inc.) MinWool-1200.

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- .4 **Fire Rated Premoulded Mineral Wool:** Non-combustible, fire-rated, rigid, sectional, longitudinally split mineral wool or basalt pipe insulation with a reinforced vapour barrier jacket and compatible with CAN4-S115 and CAN/ULC-S01 firestopping. Acceptable products are:
 - .1 ProRox PS 960;
 - .2 IIG (Johns Manville Inc.) MinWool-1200.
- .5 **Premoulded Mineral Fibre:** Rigid, sectional, sleeve type insulation to ASTM Standard C 547-00, with a factory applied vapour barrier jacket. Acceptable products are:
 - .1 Johns Manville Inc. "Micro-Lok AP-T Plus";
 - .2 Knauf Fiber Glass "Pipe Insulation" with "ASJ-SSL" jacket;
 - .3 Manson Insulation Inc. "ALLEY K APT";
 - .4 Owens Corning Fiberglas Pipe Insulation.
- .6 **Blanket Mineral Fibre:** Blanket type roll insulation to CGSB 51-GP-11M, 12 kg/m³ (3/4 lb./ft.³) density to achieve R-4.2, with a factory applied vapour barrier facing. Acceptable products are:
 - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 75;
 - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap;
 - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap;
 - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 75.
- .7 **Premoulded Weatherproof Jacketed Mineral Fibre:** Knauf Insulation "Redi-Klad 1000" sectional, sleeve type pipe insulation with a self-sealing weather-proof jacket and a 100 mm (4") butt joint sealing strip with each section.

2.4 Equipment Insulation Materials

- .1 **Blanket Mineral Fibre:** Blanket type roll form insulation to ASTM Standard C553-00, 12 kg/m³ (3/4 lb./ft.³) density to achieve R-4.2, with a factory applied vapour barrier facing. Acceptable products are:
 - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 75;
 - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap ;
 - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap;
 - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 75.
- .2 **Semi-Rigid Mineral Fibre Board:** Roll form, moulded insulation to ASTM Standard C1393-00a, with a factory applied vapour barrier facing consisting of laminated aluminum foil and kraft paper. Acceptable products are:
 - .1 Knauf Fiber Glass Pipe and Tank Insulation;
 - .2 Manson Insulation Inc. "AK FLEX";

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- .3 Johns Manville Inc. Pipe and Tank Insulation "Micro-Flex";
- .4 Multi-Glass Insulation Ltd. "MULTI-FLEX MF";
- .5 Owens Corning Pipe and Tank Insulation;
- .6 Glass-Cell Fabricators Ltd. "R-Flex".
- .3 **Semi-Rigid Mineral Wool Blanket:** Equal to Roxul "Enerwrap80" flexible, black fibrous scrim faced mineral wool blanket insulation to ASTM C 553.
- .4 **Closed Cell Foamed Glass:** Pittsburgh Corning "FOAMGLAS" expanded, rigid board and block type insulation with a liquid or vapour permeability rating (as per ASTM C240) of 0.00.

2.5 Ductwork System Insulation Materials

- .1 **Rigid Mineral Fibre Board:** Preformed board type insulation to ASTM C612-00a, 48 kg/m³ (3.0 lb./ft.³) density to achieve R-4.2, with a factory applied reinforced aluminum foil and kraft paper facing. Acceptable products are:
 - .1 Knauf Fiber Glass Insulation Board with FSK facing;
 - .2 Manson Insulation Inc. "AK BOARD FSK";
 - .3 Johns Manville Inc. Type 814 "Spin-Glas";
 - .4 Owens Corning 703.
- .2 **Semi-Rigid Mineral Fibre Board:** Roll form insulation to ASTM Standard C1393 00a, consisting of cut strips of rigid mineral board insulation glued to an aluminium foil and kraft paper facing. Acceptable products are:
 - .1 Multi-Glass Insulation Ltd. "Multi-Flex MKF";
 - .2 Glass-Cell Fabricators Ltd. "R-FLEX";
 - .3 Owens Corning Pipe and Tank Insulation;
 - .4 Johns Manville Inc. Pipe and Tank Insulation.
- .3 **Blanket Mineral Fibre:** Blanket type roll form insulation to ASTM Standard C553-00, 12 kg/m³ (3/4 lb./ft.³) density to achieve R-4.2, with a factory applied vapour barrier facing. Acceptable products are:
 - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 75;
 - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap;
 - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap;
 - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 75.
- .4 **Flexible Foam Elastomeric Sheet:** Sheet form, CFC free, closed cell, self-adhering elastomeric nitrile rubber insulation with a water vapour permeability rating of 0.08 in accordance with ASTM E96 Procedure A. Acceptable products are:
 - .1 Armacell "AP/Armaflex SA";
 - .2 IK Insulation Group "K-Flex Duct Wrap", S2S.

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2.6 Fire Rated Duct Wrap

- .1 Flexible, non-combustible, blanket type mineral fibre duct wrap completely encapsulated in reinforced foil, 40 mm (1½") thick, suitable for installation with zero clearance to combustibles, and ULC tested and listed (ULC Designs FRD-3 & 5 for ventilation ducts, ULC Design FRD-4 for kitchen exhaust duct) to facilitate a 1 or 2 hour fire resistance rating to kitchen grease exhaust duct in accordance with requirements of NFPA-96, and/or a 1 or 2 hour fire resistance rating to ventilation or pressurization ductwork in accordance with requirements of ISO 6944.
- .2 Acceptable manufacturers are:
 - .1 3M Fire Barrier Duct Wrap 615+;
 - .2 CL4 Inc. "CL4Fire";
 - .3 Unifrax Corp. "FyreWrap Elite 1.5";
 - .4 Morgan Thermal Ceramics "FireMaster FastWrap XL".

2.7 Insulating Coatings

- .1 Equal to Robson Thermal Manufacturing Ltd. insulating coatings as follows:
 - .1 anti-condensation coating, "No Sweat-FX";
 - .2 thermal insulating coating, "ThermaLite".

2.8 Insulation Fastenings

- .1 **Wire:** Minimum #15 gauge galvanized annealed wire.
- .2 **Wire Mesh:** Minimum #15 gauge galvanized annealed wire factory woven into 25 mm (1") hexagonal mesh.
- .3 **Aluminium Banding:** Equal to ITW Insulation Systems Canada "FABSTRAPS" minimum 12 mm (½") wide, 0.6 mm (1/16") thick aluminium strapping.
- .4 **Stainless Steel Banding:** Equal to ITW Insulation Systems Canada "FABSTAPS" 0.6 mm (1/16") thick, minimum 12 mm (½") wide type 304 stainless steel strapping.
- .5 **Duct Insulation Fasteners:** Weld-on 2 mm (3/32") diameter zinc coated steel spindles of suitable length, complete with minimum 40 mm (1½") square plastic or zinc plated steel self-locking washers.
- .6 **Tape Sealant:** Equal to MACTac Canada Ltd. self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match the surface being sealed.
- .7 **Adhesive - Mineral Fibre Insulation:** Clear, pressure sensitive, brush consistency adhesive, suitable for a temperature range of -20°C to 82°C (-4°F to 180°F), compatible with the type of material to be secured, and WHMIS classified as non-hazardous.
- .8 **Adhesive – Flexible Elastomeric Insulation:** Armacell "Armaflex" #520 air-drying contact adhesive.

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- .9 **Lagging Adhesive:** White, brush consistency, ULC listed and labelled, 25/50 fire/smoke rated lagging adhesive for canvas jacket fabric, suitable for colour tinting, complete with fungicide and washable when dry.
- .10 **Sheet Metal Screws:** No. 10 stainless steel sheet metal screws.

2.9 Insulation Jackets and Finishes

- .1 **Canvas:** ULC listed and labelled, 25/50 rated, roll form, minimum 170 g (6 oz.) canvas jacket material.
- .2 **White PVC:** Roll form sheet and fitting covers, minimum 15 mil thick white PVC, 25/50 rated, complete with installation and sealing accessories. Acceptable products are:
 - .1 Proto Corp. "LoSMOKE";
 - .2 The Sure-Fit System "SMOKE-LESS 25/50";
 - .3 Johns Manville Inc. "Zeston" 300.
- .3 **Rigid Aluminium:** Equal to ITW Insulation Systems Canada "Lock-on" 0.406 mm (0.016") thick embossed aluminum jacket material to ASTM B209, factory cut to size and complete with polysurlyn moisture barrier and continuous modified Pittsburgh Z-Lock, and "Fabstraps" and butt straps with weatherproof the end to end joints. Fittings are to be two-piece epoxy coated pressed aluminum with weather locking edges.
- .4 **Stainless Steel:** Equal to ITW Insulation Systems Canada "Lock-on" 0.254 mm (0.010") thick type 304 embossed stainless steel to ASTM A240, factory cut to size and complete with moisture barrier and continuous modified Pittsburgh Z-Lock, and butt straps with "Fabstraps" to cover end to end joints. Fittings are to be two piece pressed stainless steel with weather locking edges.
- .5 **Adhesive Backed Flexible Aluminium:** MFM Building Products Corp. "Flex-Clad 400" roll form sheet material with an aggressive rubberized asphalt adhesive backing, high density polyethylene reinforcement, and an embossed aluminum facing.
- .6 **Protective Coating - Flexible Foam Elastomeric Insulation:** Equal to Armacell "WB Armaflex" weatherproof, water-based latex enamel finish.

PART 3 - EXECUTION

3.1 General Insulation Application Requirements

- .1 Unless otherwise specified, do not insulate the following:
 - .1 factory insulated equipment and piping;
 - .2 heating piping within radiation unit enclosures, including blank filler sections of enclosures;
 - .3 heating piping in soffits and/or overhang spaces and connected to bare element radiation in the spaces;
 - .4 branch potable water piping located under counters to serve counter mounted plumbing fixtures and fittings, except barrier-free lavatories;

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- .5 exposed chrome plated potable water angle supplies from concealed piping to plumbing fixtures and fittings, except barrier-free lavatories;
 - .6 heated liquid system pump casings, valves, strainers and similar accessories;
 - .7 heating system expansion tanks;
 - .8 fire protection pump casings;
 - .9 manufactured expansion joints and flexible connections;
 - .10 acoustically lined ductwork and/or equipment;
 - .11 flexible branch ductwork from sheet metal ducts to grilles or diffusers;
 - .12 fire protection system water storage tanks;
 - .13 piping unions, except for unions in "cold" category piping.
- .2 Install insulation directly over pipes and ducts and not over hangers and supports.
 - .3 Install piping insulation and jacket continuous through pipe openings and sleeves.
 - .4 Install duct insulation continuous through walls, partitions, and similar surfaces except at fire dampers.
 - .5 When insulating "cold" piping and equipment, extend insulation up valve bodies and other such projections as far as possible, and protect the insulation jacketing from the action of condensation at its junction with the metal.
 - .6 Insulate, vapour seal, and finish all seismic restraints, braces, anchors, hanger rods, and similar hardware directly connected to "cold" piping and/or equipment, for a distance of 300 mm (12") clear of the adjacent pipe or equipment finish, to match the piping and/or equipment insulation.
 - .7 When insulating vertical piping risers 75 mm diameter and larger, use insulation support rings welded directly above the lowest pipe fitting, and thereafter at 4.5 m centres and at each valve and flange. Insulate as per Thermal Insulation Association of Canada National Insulation Standards, Figure No. 9.
 - .8 Where piping and/or equipment is traced with electric heating cable, ensure that the cable has been tested and accepted prior to the application of insulation, and ensure that the cable is not damaged or displaced during the application of insulation.
 - .9 Where existing insulation work is damaged as a result of a new mechanical work, repair the damaged insulation work to new work standards.
 - .10 Where mineral fibre rigid sleeve type insulation is terminated at valves, equipment, unions, etc., neatly cover the exposed end of the insulation with a purpose made PVC cover on "cold" piping, and with canvas jacket material on "hot" piping.
 - .11 Carefully and neatly gouge out insulation for proper fit where there is interference between weld bead, mechanical joints, etc., and insulation. Bevel away from studs and nuts to permit their removal without damage to insulation, and closely and neatly trim around extending parts of pipe saddles.

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- .12 Where thermometers, gauges, and similar instruments occur in insulated piping, and where access to heat transfer piping balancing valve ports and similar items are required, create a neat, properly sized hole in the insulation and provide a suitable grommet in the opening.

3.2 Insulation for Horizontal Pipe at Hangers and Supports

- .1 At each hanger and support location for piping 50 mm (2") diameter and larger and scheduled to be insulated, except where roller hangers and/or supports are required, and unless otherwise specified, supply a factory fabricated section of phenolic foam pipe insulation with integral vapour barrier jacket and captive galvanized steel shield. Supply the insulation sections to the piping installers for installation as the pipe is erected.
- .2 For 100 mm (4") diameter and larger heating system piping where roller type hangers and supports are provided, a steel saddle will be tack welded to the pipe at each roller hanger or support location. Pack saddle voids with loose mineral wool insulation.

3.3 Pipe Insulation Requirements - Mineral Fibre

- .1 Insulate the following pipe inside the building and above ground with mineral fibre insulation of the thickness indicated:
 - .1 domestic cold water piping to and including 100 mm (4") dia. – 25 mm (1") thick;
 - .2 domestic cold water piping larger than 100 mm (4") dia. – 40 mm (1½") thick;
 - .3 domestic hot water piping, to and including 40 mm (1½") dia. – 25 mm (1") thick;
 - .4 domestic hot water piping, larger than 40 mm (1½") dia. – 40 mm (1½");
 - .5 tempered domestic water piping, supply and return, to and including 40 mm (1½") dia. – 25 mm (1") thick;
 - .6 tempered domestic water piping, supply and return, larger than 40 mm (1½") dia. – 50 mm (2") thick;
 - .7 hot water heating piping, supply and return, to 40 mm (1½") dia. – 40 mm (1½") thick;
 - .8 hot water heating piping, supply and return, 40 mm (1½") dia. and larger – 40 mm (1½") thick [50 mm (2") thick if higher temperature application with non-condensing boiler];
- .2 **Piping:** Ensure that the overlap flap of the sectional insulation jacket is secured tightly in place. Cover section to section butt joints with tape sealant.
- .3 **Fittings:** Insulate fittings with sectional pipe insulation mitred to fit tightly, and cover butt joints with tape sealant, or, alternatively, wrap fittings with blanket mineral fibre insulation to a thickness and insulating value equal to the sectional insulation, secure in place with adhesive and/or wire, and cover with PVC fitting covers.

Mechanical Insulation

- .4 **"Cold" Piping Unions, Valves, Strainers, Etc.:** Unless otherwise specified, insulate unions, valves, strainers, and similar piping system accessories in "cold" piping such as domestic water or chilled water piping with cut and tightly fitted segments of sectional pipe insulation with all joints covered with tape sealant, or, alternatively, wrap the piping union, valve, strainer, etc., with blanket mineral fibre and cover with PVC covers as for "Fittings" above.
- .5 **Flanges and Mechanical Couplings:** Terminate sectional insulation approximately 50 mm (2") from the flange or coupling on each side of the flange or coupling. Cover the flange or coupling with a minimum 50 mm (2") thickness of blanket mineral fibre insulation wide enough to butt tightly to the ends of the adjacent sectional insulation. Secure the blanket insulation in place and cover with a purpose made purpose made PVC coupling cover.
- .6 **Fire Protection Piping Drum Drips:** Drum drips in dry zone sprinkler and/or standpipe system piping will be traced with electric heating cable as part of the electrical work and are generally not shown on the drawing(s). Confirm the number and size of the drum drips required with the trade providing the piping and include for the insulation to suit. Note that wherever possible drum drips will be located in heated areas.

3.4 Pipe Insulation Requirements – Mineral Wool

- .1 Insulate the following pipe inside the building and above ground with high temperature mineral wool insulation of the thickness indicated:
 - .1 high pressure (above 415 kPa-60 psi) steam piping to 40 mm (1½") dia. – 100 mm (4") thick;
 - .2 high pressure (above 415 kPa-60 psi) steam piping, 40 mm (1½") dia. and larger – 112 mm (4½") thick;
 - .3 high pressure condensate piping – 50 mm (2") thick;
 - .4 engine-generator set exhaust system piping – 75 mm (3") thick;
- .2 **Piping:** Generally, install as specified above for mineral fibre insulation.
- .3 **Fittings, Valve, Etc.:** Generally, install as specified above for mineral fibre insulation but cover with canvas, not PVC fitting covers.

3.5 Pipe Insulation Requirements – Flexible Foam Elastomeric (closed cell)

- .1 Install flexible elastomeric pipe insulation in strict accordance with the manufacturer's published instructions to suit the application, and using adhesive, joint sealants and finish to produce a water-tight installation. Insulate the following pipe with flexible elastomeric pipe insulation of the thickness indicated.
 - .1 refrigerant suction and hot gas piping outside the building – 25 mm (1") thick.

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3.6 Pipe Insulation Requirements – Closed Cell Foamed Glass

- .1 Install closed cell foamed glass insulation in strict accordance with the manufacturer's published instructions to suit the application, and using adhesive, joint sealants, and jacketing to produce a 100% water-tight installation. Insulate the following pipe with closed cell foamed glass of the thickness indicated:
 - .1 Steam piping outside the building - 113mm (4.5");
 - .2 Chilled water outside the building - . 25 mm (1")

3.7 Pipe Insulation Requirements – Fire Rated Insulation

- .1 Where pipe (inside the building and above ground) which is to be insulated as specified above penetrates fire rated construction, provide fire-rated, non-combustible sectional insulation on the portion of pipe in the fire barrier and for a distance of 50 mm (2") on either side of the fire barrier. Insulation thickness is to be as specified, but in any case, minimum 25 mm (1").

3.8 Ductwork Insulation Requirements - Mineral Fibre

- .1 Insulate the following ductwork systems inside the building and above ground with mineral fibre insulation of the thickness indicated:
 - .1 all outside air intake ductwork, casings and plenums from fresh air intakes to and including mixing plenums or sections, or, if mixing plenums or sections are not provided, to the first heating coil, or if both mixing plenums or sections and heating coil sections are not provided, and the fresh air is not tempered, then the fresh air ductwork system complete – minimum 40 mm (1½") thick as required;
 - .2 mixed supply air or preheated supply air casings, plenums and sections to and including the fan section where not factory insulated – minimum 25 mm (1") thick rigid board or minimum 40 mm (1½") thick flexible blanket as required;
 - .3 supply air ductwork outward from fans, except for supply ductwork exposed in the area it serves – minimum 25 mm (1") thick rigid board or minimum 40 mm (1½") thick flexible blanket as required;
 - .4 exhaust discharge ductwork for a distance of 3 m (10') downstream (back) from exhaust openings to atmosphere, including any exhaust plenums within the 3 m (10') distance – minimum 25 mm (1") thick rigid board or minimum 40 mm (1½") thick flexible blanket as required;
 - .5 any other ductwork, casings, plenums or sections specified or detailed on the drawings to be insulated – thickness as specified.
- .2 Insulation for casings, plenums, and exposed rectangular ductwork is to be rigid board type. Insulation for round ductwork and concealed rectangular ductwork is to be blanket type. Insulation shall be minimum 75mm (3") thick fiberglass rigid board 3.0 lbs density in 2 layers to achieve R-12 as required.

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- .3 **Concealed Rectangular or Oval Ductwork:** Liberally apply adhesive to all surfaces of the duct and wrap the insulation around the duct with a top butt joint and tight section to section butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom surfaces. Secure and seal all joints with 75 mm (3") tape sealant. Additional installation requirements are as follows:
 - .1 at each trapeze type duct hanger provide a 100 mm (4") wide full length piece of rigid mineral fibre board insulation between the duct and the hanger.
- .4 **Exposed & Concealed Round or Oval Ductwork:** Accurately cut sections of insulation to fit tightly and completely around the duct. Liberally apply adhesive to all surfaces of the duct and wrap the insulation around the duct with a top butt joint and tight section to section butt joints. Seal all joints with tape sealant. At duct hanger locations install the insulation between the duct and hanger. At each hanger location for concealed ductwork where flexible blanket insulation is used, provide a 100 mm (4") wide full circumference strip of semi-rigid board type duct insulation between the duct and the hanger.
- .5 **Common Duct Insulation Requirements:** Insulation application requirements common to all types of rigid ductwork are as follows:
 - .1 at duct connection flanges insulate the flanges with neatly cut strips of the rigid insulation material secured with adhesive to side surfaces of the flange with a top strip to cover the exposed edges of the side strips, then butt the flat surface duct insulation up tight to the flange insulation, or, alternatively, increase the insulation thickness to the depth of the flange and cover the top of the flanges with tape sealant;
 - .2 the installation of fastener pins and washers is to be concurrent with the duct insulation application;
 - .3 cut insulation fastener pins almost flush to the washer and cover with neatly cut pieces of tape sealant;
 - .4 accurately and neatly cut and fit insulation at duct accessories such as damper operators (with standoff mounting) and pitot tube access covers;
 - .5 prior to concealment of insulation by either construction finishes or canvas jacket material, patch all vapour barrier damage by means of tape sealant.

3.9 Ductwork Insulation Requirements - Flexible Elastomeric

- .1 Insulate all exposed exterior ductwork (except fresh air intake ductwork) and associated plenums and/or casings outside the building with minimum 40 mm (1½") thick flexible elastomeric sheet insulation as required, applied in two minimum 20 mm (¾") thick layers with staggered tightly butted joints.
- .2 Install with adhesive in strict accordance with the manufacturer's published instructions to produce a weather-proof installation. Ensure that sheet metal work joints are sealed watertight prior to applying insulation.

3.10 Duct Wrap Requirements – Fire Rated Material

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- .1 Provide blanket type fire rated duct wrap system material for the following ductwork to produce the fire rating indicated:
 - .1 fume hood exhaust ductwork; on level S of new building
 - .2 stairwell pressurization ductwork;
 - .3 Dryer exhaust ductwork on level S of building H;xz
 - .4 Supply/Return ductwork on level 4 of new building;
 - .5 New generators engine exhaust.
 - .6 And other ductwork with fire wrap indicated on mechanical drawings.
- .2 Install the duct wrap material in accordance with ULC design requirements and the wrap supplier's instructions.
- .3 Coordinate installation of duct wrap with the installation of the ductwork.
- .4 Arrange and pay for the duct wrap supplier to examine the completed duct wrap system at the site. Submit a letter from the supplier to certify that the duct wrap system has been properly installed.

3.11 Application of Insulating Coatings

- .1 Apply, in accordance with the manufacturer's instruction, insulating coatings to the following bare metal surfaces:
 - .1 paint all bare metal surfaces clear of "cold" piping and/or equipment insulation for a distance of from 300 mm (12") to 600 mm (24") clear of the pipe or equipment insulation, with "No Sweat-FX" anti-condensation coating;
 - .2 paint all bare metal surfaces associated with mechanical systems with an operating temperature 60°C (140°F) with "ThermaLite" insulating coating.
- .2 Apply coatings with a brush. Remove any splatter or excess coating from adjacent surfaces.

3.12 Insulation Finish Requirements

- .1 **Canvas:** Unless otherwise shown and/or specified, jacket all exposed mineral fibre insulation, and calcium silicate duct insulation work inside the building with canvas secured in place with a full 100% covering coat of lagging adhesive. Accurately cut canvas with scissors or a knife. Do not rip or tear canvas to size. Remove lagging adhesive splatter from adjacent uninsulated surfaces.
- .2 **White PVC:** Jacket exposed pipe insulation work inside the building with white sheet PVC and fitting covers. Install sheet PVC and fitting covers tightly in place with overlapped circumferential and longitudinal joints arranged to shed water. Seal all joints to produce a neat water-tight installation. Provide slip-type expansion joints where required by manufacturer's instructions.
- .3 **Rigid Aluminum:** Install aluminum jacket material tightly in place with overlapped circumferential joints positioned to shed water and covered with butt straps supplied with the jacket. Provide aluminum jacket for the following insulation:

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- .1 Steam piping outside the building;
- .2 Chilled water outside the building
- .3 Refrigerant suction and hot gas piping outside the building;
- .4 **Protective Coating - Foamed Glass Insulation:** Apply two heavy coats of "PITTCOTE 404" coating with 24 hr. between coats to all foamed glass insulation exposed above grade.
- .5 **Protective Coating – Flexible Elastomeric Insulation:** Apply 2 coats (with 24 hr. between coats) of the specified coating to all insulation outside the building.

END OF SECTION

Demolition and Revision Work

PART 1 - GENERAL

1.1 Application

- .1 This Section specifies requirements, criteria, methods and execution for mechanical demolition work that are common to one or more mechanical work Sections, and it is intended as a supplement to each Section and is to be read accordingly.

1.2 Submittals

- .1 Submit documentation to confirm that reclaimed refrigerant has been properly removed and stored, recycled, or disposed of as applicable.

PART 2 - PRODUCTS

2.1 Not Applicable

PART 3 - EXECUTION

3.1 Disconnection and Removal of Existing Mechanical Work

- .1 Where indicated on the contract documents, disconnect and remove existing mechanical work, including hangers, supports, insulation, etc. Disconnect at the point of supply, remove obsolete connecting services and make the system safe. Cut back obsolete piping behind finishes and cap water-tight unless otherwise specified.
- .2 The scope and extent of the demolition or revision work is only generally indicated on the contract documents. Estimate the scope, extent and cost of the work at the site during the bidding period site visit(s). Claims for extra costs for demolition work not shown or specified but clearly visible or ascertainable at the site during bidding period site visits will not be allowed.
- .3 If any re-design is required due to discrepancies between the mechanical contract documents and site conditions, notify the Consultant who will issue a Site Instruction. If, in the opinion of the Consultant, discrepancies between the mechanical contract documents and actual site conditions are of a minor nature, the required modifications are to be done at no additional cost.
- .4 Where existing mechanical services extend through, or are in an area to serve items which are to remain, maintain the services in operation. Include for rerouting existing services concealed behind existing finishes and which become exposed during the renovation work, so as to be concealed behind new or existing finishes.
- .5 Unless otherwise specified, remove from the site and dispose of all existing materials which have been removed and are not to be relocated or reused. Refer to waste management and disposal requirements specified in the mechanical work Section entitled Basic Mechanical Materials and Methods.
- .6 Unless otherwise specified, remove from the site and dispose of all existing materials which have been removed and are not to be relocated or reused, except for the following which are to be handed over to the Owner at the site:

Demolition and Revision Work

- .1 Plumbing fixtures and fittings in good condition.

3.2 Hazardous Waste

- .1 Be advised that items such as drainage sumps, catch basins, interceptors, and the like may contain unidentified hazardous waste and caution is to be taken when disconnecting and removing these items.
- .2 If hazardous waste not listed in the Specification is found, notify the Owner and Consultant immediately and await directions.

3.3 Interruption to and Shut-Down of Mechanical Services And Systems

- .1 Co-ordinate all shut-down and interruption to existing mechanical systems with the Owner. Generally, shut-downs may be performed only between the hours of 12:00 midnight Friday until 6:00 a.m. Monday morning.
- .2 Upon award of contract, submit a list of anticipated shut-down times and their maximum duration.
- .3 Prior to each shut-down or interruption, inform the Owner in writing seventy-two hours in advance of the proposed shut-down or interruption and obtain written approval to proceed. Do not shut-down or interrupt any system or service without such written approval.
- .4 Perform work associated with shut-downs and interruptions as continuous operations to minimize the shut-down time and to reinstate the systems as soon as possible, and, prior to any shut-down, ensure that all materials and labour required to complete the work for which the shut-down is required are available at the site.
- .5 **Pipe Freezing:** Pipe freezing may be used to connect new piping to existing piping without draining the existing piping. Pipe freeze equipment is to be equal to "NORDIC FREEZE" equipment supplied by Mag Tool Inc. or Rigid Tool Co. RIGID "SuperFreeze".

END OF SECTION

Testing, Adjusting and Balancing

PART 1 - GENERAL

1.1 Application

- .1 This Section specifies mechanical system testing, adjusting, and balancing requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.2 Submittals

- .1 **Name and Qualifications of Testing and Balancing Agency:** Within thirty days of work commencing at the site, submit the name and qualifications of the proposed testing and balancing agency in accordance with requirements of the article entitled Quality Assurance below.
- .2 **Sample Test Forms:** Submit sample test forms, if other than those standard forms prepared by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) are proposed for use.
- .3 **Drawing Evaluation Report:** Submit a report by the Agency to indicate the Agency's evaluation of the mechanical drawings with respect to service routing and location or lack of balancing devices. Include the set of drawings used and marked-up by the Agency to prepare the report.
- .4 **Site Visit Reports:** Submit a report by the Agency after each site visit made by the Agency during the construction phase of this Project.
- .5 **Draft Report:** Submit a draft report, as specified in Part 3 of this Section.
- .6 **Final Report:** Submit a final report, as specified in Part 3 of this Section.
- .7 **Warranty:** Submit a testing and balancing warranty as specified in Part 3 of this Section.
- .8 **Post Construction Site Visit Reports:** Submit reports listing observations and results of post construction site visits as specified in Part 3 of this Section.

1.3 Definitions

- .1 The following are definitions of words used in this Section:
 - .1 "TAB" – means testing, adjusting and balancing to determine and confirm quantitative performance of equipment and systems and to regulate the specified fluid flow rate and air patterns at the terminal equipment, e.g., reduce fan speed, throttling, etc.;
 - .2 "hydronic systems" – includes heating water, chilled water, glycol-water solution, condenser water, and any similar system;
 - .3 "air systems" – includes all outside air, supply air, return air, exhaust air, and relief air systems;
 - .4 "flow rate tolerance" – means the allowable percentage variation, minus to plus, of actual flow rate values in the Contract Documents;
 - .5 "report forms" – means test data sheets arranged for collecting test data in

Testing, Adjusting and Balancing

logical order for submission and review, and these forms, when reviewed and accepted, should also form the permanent record to be used as the basis for required future testing, adjusting and balancing;

- .6 “terminal” – means the point where the controlled fluid enters or leaves the distribution system, and these are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods;
- .7 “main” – means the duct or pipe containing the system’s major or entire fluid flow;
- .8 “submain” – means the duct or pipe containing part of the systems’ capacity and serving two or more branch mains;
- .9 “branch main” – means duct or pipe servicing two or more terminals;
- .10 “branch” – means duct or pipe serving a single terminal.

1.4 Quality Assurance

- .1 **Testing and Balancing Agency:** Employ the services of an independent testing, adjusting, and balancing agency meeting the qualifications specified below, to be the single source of responsibility to test, adjust, and balance the building mechanical systems to produce the design objectives. The testing, adjusting and balancing agency is to have successfully completed testing, adjusting and balancing of mechanical systems for a minimum of five projects similar to this Project within the past three years, and is to be certified as an independent agency **in all required categories** by one of the following:
 - .1 AABC - Associated Air Balance Council;
 - .2 NEBB - National Environmental Balancing Bureau;
- .2 **Standards:** Testing, adjusting and balancing of the complete mechanical systems is to be performed over the entire operating range of each system in accordance with one of the following publications:
 - .1 National Standards For A Total System Balance published by the Associated Air Balance Council;
 - .2 Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems published by the National Environmental Balancing Bureau;
 - .3 Chapter 39, Testing, Adjusting, and Balancing of ASHRAE Handbook HVAC Applications.

1.5 Acceptable list of TAB firms:

- .1 Air Adjustments & Balancing Inc.;
- .2 Designtest & Balancing Co Ltd.;
- .3 Dynanic Flow Balancing;
- .4 Enviro Balance Inc.;
- .5 Verify.

Testing, Adjusting and Balancing

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 Scope of Work

- .1 Perform total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications and comfort conditions, and recording and reporting the results.
- .2 Mechanical systems to be tested, adjusted and balanced include:
 - .1 **Heating Systems:** TAB of heating systems is to include all piping and equipment fluid temperatures, pressure, flows and control, and if TAB is not done during the heating season, a follow-up site visit during the heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
 - .2 **Air Handling Systems:** TAB of air handling systems is to include all equipment and ductwork air temperatures, capacities and flows.
 - .3 **Existing Systems:** All of the existing systems revised as part of the mechanical work, are to be tested, adjusted and balanced as for new systems.

3.2 Testing, Adjusting and Balancing

- .1 **General Requirements:** Conform to the following requirements:
 - .1 as soon as possible after award of Contract, the Agency is to carefully examine a white print set of mechanical drawings with respect to routing of services and location of balancing devices, and is to issue a report listing the results of the evaluation;
 - .2 the set of drawings examined by the Agency is to be returned with the evaluation report, with red line mark-ups to indicate locations for duct system test plugs, and required revision work such as relocation of balancing devices and locations for additional devices;
 - .3 after review of the mechanical work drawings and specification, the Agency is to visit the site at frequent, regular intervals during construction of the mechanical systems, to observe routing of services, locations of testing and balancing devices, workmanship, and anything else that will affect testing, adjusting and balancing;
 - .4 after each site visit, the Agency is to report results of the site visit indicating the date and time of the visit, and detailed recommendations for any corrective work required to ensure proper adjusting and balancing;
 - .5 testing, adjusting and balancing is not to begin until:
 - .1 building construction work is substantially complete and doors have been installed;

Testing, Adjusting and Balancing

- .2 mechanical systems are complete in all respects, and have been checked, started, adjusted, and then successfully performance tested.
- .6 all mechanical systems to be tested, adjusted and balanced are to be maintained in full, normal operation during each day of testing, adjusting and balancing;
- .7 obtain copies of reviewed shop drawings of all applicable mechanical plant equipment and terminals, and temperature control diagrams and sequences;
- .8 the Agency is to walk each system from the system "head end" equipment to terminal units to determine variations of installation from design, and the system installation trades will accompany the Agency;
- .9 the Agency is to check all valves and dampers for correct and locked position, and temperature control systems for completeness of installation before starting equipment;
- .10 wherever possible, the Agency is to lock all balancing devices in place at the proper setting, and permanently mark settings on all devices;
- .11 for belt-driven equipment, the Agency is to report to the Commissioning Agent who in turn is to inform the Contractor and Consultant of any situation where sheaves have to be replaced to suit testing and balancing, and replacements are to be done by the Contractor at no cost;
- .12 the Agency is to leak test all ductwork as specified in Section 23 31 05 in accordance with requirements of SMACNA "HVAC Air Duct Leak Test Manual", coordinate work with the work of Section 23 31 05, provide detailed sketch(es) to Sheet Metal Contractor and Consultant identifying ductwork not in accordance with acceptable leakage values specified in Section 23 31 05 and 23 31 06, and retest corrected ductwork;
- .13 **noise:** the Agency is to balance all systems with due regard to objectionable noise which is to be a factor when adjusting fan speeds and performing terminal work such as adjusting air quantities, and should objectionable noise occur at the design conditions, the Agency is to immediately report the problem and submit data, including sound readings, to permit an accurate assessment of the noise problem to be made;
- .14 **stratification:** the Agency is to check all supply air handling system mixing plenums for stratification, and where the variation of mixed air temperature across coils is found to be in excess of plus or minus 5 percent of design requirements, the Agency is to report the problem and issue a detail sketch of plenum baffle(s) required to eliminate the stratification;
- .15 **tolerances:** the Agency is to perform testing, adjusting and balancing to within plus or minus 5% of design values, and make and record measurements using instruments with minimum accuracy which are within plus or minus 2% of required values;
- .16 **filters** for all air handling systems equipped with air filters, test and balance the systems with simulated 50% loaded (dirty) filters by providing a false pressure drop;

Testing, Adjusting and Balancing

- .17 **seasonal requirements:** test, adjust and balance air conditioning systems during the summer season and heating systems during winter season, including at least a period of operation at outside conditions within 2.8°C (5°F) wet bulb temperature of maximum summer design condition, and within 5.5°C (10°C) dry bulb temperature of minimum winter design condition, and take final temperature readings during seasonal operation.
- .2 **Preparation of Reports:** Prepare reports as indicated below.
 - .1 **Draft Reports:** Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on AABC or NEBB forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit two complete sets of draft reports. Only one complete set of draft reports will be returned.
 - .2 **Final Report:** Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. Use units of measurement (SI or Imperial) as used on the Project Documents.
 - .3 **Report Format:** Report forms are to be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the divisions listed below, separated by divider tabs:
 - .1 General Information and Summary;
 - .2 Air Systems;
 - .3 Hydronic Systems;
 - .4 Temperature Control Systems;
 - .4 **Report Contents:** The Agency is to provide the following minimum information, forms and data:
 - .1 inside cover sheet to identify the Agency, the Contractor, and Project, including addresses, and contact names and telephone numbers and a listing of the instrumentation used for the procedures along with the proof of calibration;
 - .2 the remainder of the report is to contain the appropriate forms containing as a minimum, the information indicated on the standard AABC or NEBB report forms prepared for each respective item and system;
 - .3 the Agency is to include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "as-built" diagram indicating and identifying all equipment, terminals, and accessories;
 - .4 the Agency is to include report sheets indicating building comfort test readings for all rooms.

Testing, Adjusting and Balancing

- .3 **Verification of Reports:** After the final testing and balancing report has been submitted, the Agency is to visit the site with the Contractor and Consultant to spot check results indicated on the balancing report. The Agency is to supply all labour, ladders, and instruments to complete spot checks. Note that if results of spot checks do not, on a consistent basis, agree with the final report, the spot check procedures will stop and the Agency is to then rebalance the systems involved, resubmit the final report, and again perform spot checks with the Contractor and Consultant.
- .4 **Certification and Warranty:** When the final report has been accepted, the Contractor is to submit to the Owner, in the name of the Owner, a certificate equal to the AABC National Guaranty Certification or a NEBB Quality Assurance Program Bond, and in addition, the Contractor is to submit a written extended warranty from the Agency covering one full heating season and one full cooling season, during which time any balancing problems which occur, with the exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by the Agency and reported on to the Owner, and if it is determined that the problems are a result of improper testing, adjusting and balancing, they are to be immediately corrected without additional cost to the Owner.
- .5 **Post Balancing Site Visits:** After acceptance of the final report, the Agency is to perform post testing and balancing site visits in accordance with the following requirements:
 - .1 post testing and balancing site visits are to be made:
 - .1 once during the first month of building operation;
 - .2 once during the third month of building operation;
 - .3 once between the fourth and tenth months in a season opposite to the first and third month visit.
 - .2 during each return visit and accompanied by the Owner's representative, the Agency is to spot rebalance terminal units as required to suit building occupants and eliminate complaints;
 - .3 the Agency is to schedule each visit with the Contractor and the Owner, and inform the Consultant;
 - .4 after each follow-up site visit, the Agency is to issue to the Contractor and Consultant a report indicating any corrective work performed during the visit, all abnormal conditions and complaints encountered, and recommended corrective action.

END OF SECTION

Fire Suppression Sprinkler Systems

PART 1 - GENERAL

1.1 Submittals

- .1 **Shop Drawings/Product Data:** Submit shop drawings/product data sheets to the regulatory authority for review and approval prior to submitting to the Consultant. Conform to the following requirements:
 - .1 submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings;
 - .1 Sprinklers shall be referred to on drawings and product submittals and be specifically identified by the manufacturer's listed model or series designation. Trade names and other abbreviated listings are not allowed.
 - .2 submit complete white print CAD layout drawings indicating the source of water supply with test flow and pressure, "head-end" equipment piping schematic, pipe routing and sizing, sprinkler heads layout and zones, all signed and sealed by a qualified professional mechanical engineer as specified below;
 - .3 submit copies of all calculations, including hydraulic calculations, stamped and signed by the same engineer who signs the layout drawings, and a listing of all design data used in preparing the calculations, system layout and sizing, including occupancy-hazard design requirements;
 - .4 in addition to submitting shop drawings to the regulatory authority as specified above, shop drawings must be approved by the Owner's insurer prior to being submitted to the Consultant for review.
- .2 **Test Certificate:** Submit a complete sprinkler system test certificate as specified in Part 3 of this Section.

1.2 Quality Assurance

- .1 **Codes and Standards:** Fire protection standpipe system work is to be in accordance with the following Codes and Standards:
 - .1 NFPA 13, Standard for the Installation of Sprinkler Systems;
 - .2 NFPA 25 Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems)
 - .3 NFPA 70 National Electrical Code.
 - .4 NFPA 72 National Fire Alarm Code.
 - .5 National Building Code.
 - .6 National Fire Code
 - .7 CAN/ULC-S524 (Standard for the Installation of Fire Alarm Systems)
 - .8 CAN/ULC-S537 (Standard for the Verification of Fire Alarm Systems)
 - .9 Requirements of authority having jurisdiction (AHJ).

Fire Suppression Sprinkler Systems

- .10 ANSI/CAN/UL 213, Standard for Safety for Rubber Gasketed Fittings for Fire Protection Service
- .11 CSA B137.2, PVC Injection-Molded Gasketed Fittings for Cold-Water Pressure Services;
- .12 CSA B137.3, Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications;
- .13 ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless;
- .14 ASTM A135, Standard Specification for Electric-Resistance-Welded Steel Pipe;
- .15 ASTM A234, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service;
- .16 ASTM A536, Standard Specification for Ductile Castings;
- .17 ASTM A795, Standard Specification for Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use;
- .18 ASTM F3226, Standard Specification for Metallic Press-Connect Fittings for Piping and Tubing Systems
- .19 ANSI/ASME B16.4, Grey Iron Threaded Fittings (Classes 125 and 250);
- .20 CAN/CSA B64.10, Backflow Preventers and Vacuum Breakers.
- .21 ICC-ES AC156, Seismic Certification by Shake-table Testing of Nonstructural Components.
- .2 **Subcontractor and Site Personnel:** Fire protection sprinkler work is to be performed by a sprinkler company who is a member in good standing of the Canadian Automatic Sprinkler Association. All site personnel are to be sprinkler fitters licensed in the jurisdiction of the work and under the continuous supervision of a foreman who is an experienced fire protection system installer and a journeyman pipe fitter.
- .3 **Dimensions and Coordination:** Check and verify all dimensions and conditions at the site and ensure that the work can be performed as indicated. Co-ordinate fire protection sprinkler work with all trades at the site and accept responsibility for and the cost of making adjustments to piping and/or spacing to avoid interference with other building components.
- .4 **Existing Sprinkler Work:** Verify the working condition of all existing fire protection sprinkler system equipment which has direct interface with the new work and is to remain. Replace with new equipment where necessary.
- .5 All system components must be UL and/or ULC listed and labelled.
- .6 All grooved couplings, and fittings, valves and specialties shall be the products of a single manufacturer.
- .7 All Metallic Press-Connect fittings shall be the products of a single manufacturer.
- .8 All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.3 Design Requirements

Fire Suppression Sprinkler Systems

- .1 **Design Criteria:** Fire protection sprinkler work is to be designed in accordance with NFPA 13 and Provincial Standards, and, where required, local building and fire department requirements and the standards of the Owner's Insurer. If water supply flow and pressure test data is not available, conduct Municipal main water flow and pressure tests at the nearest fire hydrant to obtain criteria to be used in sprinkler system design. Include hydrant location and flow and pressure test data with system design calculations.
- .2 **System Designer:** Fire protection sprinkler work is to be designed by a fully qualified mechanical professional engineer registered and licensed in the jurisdiction of the work. Refer to the mechanical work Section entitled Mechanical Work General Requirements for requirements governing employment of the Engineer.
- .3 **Sprinkler /System Occupancy – Hazard Design requirements:** As per NFPA 13 occupancy-hazard density requirements, unless otherwise specified.

PART 2 - PRODUCTS

2.1 Pipe, Fittings and Joints

- .1 Pipe, fittings and joints are to be as follows, with exceptions as specified in Part 3 of this Section:
 - .1 **Schedule 40 Steel – Grooved Coupling Joints:** Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with grooved ends and mechanical fittings and couplings equal to Victaulic "FireLock" fittings and Victaulic Style 009N, 107H, and 107N QuickVic and 005 rigid coupling joints. Strap type outlet fittings such as Victaulic "Snap-Let" are not acceptable.
 - .2 **Schedule 40 Steel – Screwed and Welded Joints:** Schedule 40 mild black carbon steel, ASTM A53, Grade B. Screwed piping is to be complete with Class 125 cast iron screwed fittings to ANSI/ASME B16.4. Welded piping is to be complete with factory made seamless carbon steel butt welding fittings to ASTM A234, Grade WPB, **long sweep pattern** wherever possible.

2.2 Shut-Off Valves

- .1 Equal to Victaulic Style 705, minimum 300 psi rated full port brass or bronze body screwed ball valves and lug body or grooved end type butterfly valves.
- .2 Butterfly valves shall include a pressure responsive seat, and the stem shall be offset from the disc centreline to provide complete 360-degree circumferential seating.

2.3 Sprinkler Heads

- .1 Sprinkler heads, unless otherwise specified, are to be as scheduled in Part 3 of this Section.
- .2 Sprinkler body shall be die-cast, with a hex-shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation. Wrenches shall be provided by the sprinkler manufacturer that directly engages the wrench boss.
- .3 For locations where corrosive resistant coatings are required, body shall be coated with UL listed and FM approved anti-corrosion VC-250 coating (silver coloring).

Fire Suppression Sprinkler Systems

- .4 Recessed sprinkler heads in finished areas are to be chrome plated unless otherwise specified. Concealed sprinkler head ceiling plates are to match the ceiling colour.
- .5 Where exposed pendent heads occur in areas with suspended ceilings, they are to be complete with chrome plated escutcheon plates. Similarly, sidewall heads with concealed piping are to be complete with chrome plated escutcheon plates.
- .6 Sprinkler heads which are exposed in areas where they may be subject to damage are to be complete with wire guards, chrome plated where in finished areas.
- .7 Sprinkler heads located in areas or over equipment where high ambient temperature is present are to be, unless otherwise specified, 165°F heads. All other heads, unless otherwise specified or required, are to be 135°F rated.
- .8 Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.
- .9 Concealed type of sprinkler heads shall be used for finished spaces for healthcare application.
- .10 Acceptable sprinkler head manufactures are:
 - .1 Tyco Fire Suppression & Building Products;
 - .2 Victaulic Co.;
 - .3 The Viking Corporation;
 - .4 The Reliable Automatic Sprinkler Co.

PART 3 - EXECUTION

3.1 Demolition

- .1 Refer to demolition requirements specified in the mechanical work Section entitled Demolition and Revision Work.

3.2 Piping Installation Requirements

- .1 Provide all required sprinkler system piping.
- .2 Do all piping work in accordance with requirements of NFPA 13, governing regulations, and "reviewed" shop drawings.
 - .1 **for piping inside the building and above ground except as noted below –** Schedule 40 grooved end black steel with Victaulic or equal fittings and coupling joints, Schedule 40 black steel pipe with Metallic Press-Connect or equal joints for piping up to 4" diameter, or, for piping to and including 2" diameter, screwed fittings and joints, or, for piping 2½" diameter and larger, welding fittings and welded joints;
- .3 All pipe sizes, pipe routing, sprinkler head quantities and locations, and layout of work shown on the drawings are to assist you during the tendering period. Ensure adequate head coverage, head quantities and pipe sizing as specified in Part 1 of this Section. Do not reduce the size of the sprinkler main or re-route the main unless approved.

Fire Suppression Sprinkler Systems

- .4 All pipe, fittings, couplings, flanges and similar components are to be clean after erection is complete. Any ferrous pipe, fitting, coupling, flange, hanger, support and similar component which exhibits rust is to be wire brush cleaned and carefully coated with suitably coloured primer.
- .5 In lieu of rigid pipe offsets or return bends for sprinkler drops, a Multiple-Use Flexible Stainless Steel Sprinkler Drop System may be used to locate sprinklers as required by final finished ceiling tiles and walls.
- .6 Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks. Gaskets shall be molded and produced by the coupling manufacturer and shall be verified as suitable for the intended service. A factory-trained field representative of the mechanical joint manufacture shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. The factory-trained representative shall periodically review the product installation and ensure best practices are being followed. Contractor shall remove and replace any improperly installed products.
- .7 Metallic Press-Connect Fittings: Installer shall have been trained by manufacturer or manufacturer's representative to join piping with press-connect fittings. The installers shall have a current manufacturer credential. Join tubing/pipe and press-connect fittings with recommended tooling. The manufacturer's installation instructions shall be strictly adhered to. All connections shall bear full insertion marks on the pipe/tubing. Attention shall be given to the required two step pressure test. Initial recommended pressure test for unpressed fitting detection per manufacturer's installation manual. Following a successful step test, the system may be pressure tested up to 600 psi maximum for water and 200 psi maximum for air when required by state and or local code requirements

3.3 Installation of Sprinkler Heads

- .1 Provide all required sprinkler heads. Sprinkler head types are to be in accordance with the following schedule, unless otherwise specified. Sprinkler head manufacturers indicated on the schedule are for type indication purposes. Acceptable manufacturers are listed in Part 2 of this Section.
- .2 Unless otherwise specified, sprinkler heads are to be in accordance with the following schedule:

Fire Suppression Sprinkler Systems

APPLICATION	SPRINKLER HEAD TYPE
Healthcare Facility Type I rooms/areas as per CAN/CSA-Z317.1, Table 1, HVAC Design Criteria, first two columns	Reliable Model G4 "The Concealer" concealed sprinkler head with a dust type gasketed seal.
Healthcare Facility Type II rooms/area as per CAN/CSA-Z317.1, Table 1, HVAC Design Criteria, first two columns	Tyco Series RFII "Royal Flush II" concealed pendent
Healthcare Facility Type III rooms/areas as per CAN/CSA-Z317.1, Table 1, HVAC Design Criteria, first two columns	Tyco Series RFII "Royal Flush II" concealed pendent
Healthcare patient unit without a suspended ceiling but with a ceiling bulkhead	Tyco Series RFII "Royal Flush II" concealed pendent
Healthcare Facility MRI Suite	Reliable Model F4FR-NF non-ferrous concealed pendent
Rooms/areas with a suspended ceiling	Tyco Series RFII "Royal Flush II" concealed pendent
Rooms/areas without a suspended ceiling	Tyco Series TY-RFB pendent
Elevator shafts	Tyco Series TY-FRB horizontal sidewall
Unheated exterior stairwells	Tyco Series DS-1 dry pipe horizontal sidewall Tyco Series DS-3 wet pipe horizontal sidewall
Air handling system outdoor air and relief air plenums (unheated)	Tyco Series DS-3 ECOH dry horizontal sidewalls in wet piping Tyco Series TY-FRB upright or horizontal sidewall in dry pipe or anti-freeze piping
Unheated and unfinished areas	Tyco Series DS-3 ECOH dry horizontal sidewall in wet piping Tyco Series TY-FRB upright or horizontal sidewall in dry pipe or anti-freeze piping
Heated areas with overhead doors	Tyco Series TY-FRB horizontal sidewall
Unheated parking garage	Tyco Series EC-11 or EC-14 ECOH upright or Series TY-FRB upright for dry piping
Heated parking garage	Tyco Series EC-11 or EC-14 ECOH upright or Series TY-FRB upright for wet piping

Fire Suppression Sprinkler Systems

APPLICATION	SPRINKLER HEAD TYPE
Parking garage ramp	Tyco Series EC-11 or EC-14 ECOH upright or Series TY-FRB upright or Series ELO SW-20 or SW-24 ECOH sidewall
At non-rated windows in rated walls	Tyco Model WS horizontal and pendent vertical sidewall

- .3 Sprinkler head locations must be carefully coordinated with all drawings, including architectural reflected ceiling plan drawings, and, where applicable, electrical drawings. Coordinate sprinkler head locations in areas with suspended ceilings with the location of lighting, grilles, diffusers, and similar items recessed in or surface mounted on the ceiling as per the reflected ceiling plans. In areas with lay-in tile, centre the sprinkler head both ways in the lay-in tile wherever possible. Confirm locations prior to roughing-in.
- .4 Maintain maximum headroom in areas with no ceilings.
- .5 Provide guards for heads where they are subject to damage.
- .6 Provide high temperature heads in equipment rooms and similar areas over heat producing or generating equipment.

3.4 Installation of Spare Sprinkler Head Cabinet

- .1 Supply a full complement (to fill cabinet) of spare sprinkler heads of the types used (minimum four of each type) and place in a wall mounting storage cabinet located adjacent to the sprinkler system "head end" equipment where later directed.

Domestic Water Piping and Valves

PART 1 - GENERAL

1.1 Submittals

- .1 **Shop Drawings/Product Data:** Submit shop drawings/product data sheets for all products specified in Part 2 of this Section except for pipe and fittings, and chlorine.

1.2 Quality Assurance

- .1 Domestic water piping and valves are to comply with following codes, regulations and standards (as applicable):
 - .1 applicable local codes and regulations;
 - .2 CAN/CSA B125.1, Plumbing Supply Fittings;
 - .3 CAN/CSA B125.3, Plumbing Fittings;
 - .4 CAN/CSA B137 Series, Thermoplastic Pressure Piping Compendium;
 - .5 NSF/ANSI 14, Plastics Piping System Components and Related Materials;
 - .6 NSF/ANSI 61, Drinking Water System Components – Health Effects;
 - .7 NSF/ANSI 372, Drinking Water System Components – Lead Content.

PART 2 - PRODUCTS

2.1 Pipe, Fittings and Joints

- .1 **Soft Copper:** Type "K" soft copper to ASTM B88, supplied in a continuous coil with no joints if possible, and complete with, if joints are required, compression type flared joint couplings,
- .2 **Hard Copper - Solder Joint:** Type "L" hard drawn seamless copper to ASTM B88, complete with copper solder type fittings to ASME/ANSI B16.18 and soldered joints using The Canada Metal Co. Ltd. "SILVABRITE 100" or equal lead-free solder for cold water pipe, and 95% tin/5% Antimony or "SILVABRITE 100" solder for other services.
- .3 **Hard Copper - Grooved End Mechanical Joint:** Type "L" hard drawn seamless copper to ASTM B88, factory or site roll grooved, complete with Victaulic grooved end fittings. 607 QuickVic couplings, consisting of ductile iron housings to ASTM A 536 (Grade 65 45 12) with coating of copper alkyd enamel paint. Gasket shall be Grade "P" Fluoroelastomer compound with red and blue colour code designed for operating temperatures from 0 deg F to +180 deg F.
- .4 **Copper Pressure Coupled Joint:** Type "L" hard drawn seamless copper to ASTM B88 with "ProPress with Smart Connect feature" copper fittings with EDPM seals, and pressure type crimped joints made by use of a Rigid Tool Co. Model RP 330 or Model RP 210 electro-hydraulic crimping tool.
- .5 **CPVC:** Ipex "Aquarise" CPVC pipe and fittings to CAN/CSA B137.6, NSF 61, complete with a flame spread rating not greater than 25 and smoke developed classification not greater than 50 when tested to CAN/ULC-S102.2, with solvent weld joints, and, for fire barrier penetration, approved firestop conforming to CAN/ULC-S115.

Domestic Water Piping and Valves

- .6 **Cross-Linked Polyethylene (PEX) Tubing:** Non-barrier type PEX piping in accordance with CAN/CSA B137.5, ASTM F876 and tested for compliance by an independent third-party agency, 25/50 flame spread/smoke developed rated when tested to CAN/ULC S102.2 and complete with brass inserts and crimp-ring or cold-expansion joint fittings and couplings.

2.2 Shut-Off Valves

- .1 **Ball Valves:** 1034 KPA (150 psi) / 600 WOG rated, full port, lead free less than 0.25% brass body and certified to NSF/ANSI 61 Annex G and 372, each complete with a forged brass body with solder ends, forged brass cap, and blowout-proof stem, solid forged brass chrome plated ball, PTFE adjustable packing or double O-ring design, lever handle. Valves in insulated piping are to be complete with stem extensions. Acceptable manufacturers are:

- .1 Toyo Valve Co.;
- .2 Kitz Corporation;
- .3 Milwaukee Valve Co.;
- .4 Bray Valve and Controls Canada;
- .5 Apollo Valves;
- .6 Watts Industries (Canada) Inc.;
- .7 M.A.Stewart & Sons Ltd.

.2 CPVC Fittings and Components

- .1 IPEX AquaRise CPVC Molded fittings to CAN/CSA B137.6, NSF 61, pressure rated to 400 psi at (73°F) and 150 psi at 160°F.
- .2 IPEX AquaRise CPVC Flanges to ASTM F1970, NSF 61, pressure rated to 150 psi at 73°F and 57 psi at 160°F.
- .3 IPEX AquaRise CPVC Full Pressure Flange Kits to CSA B137.6, NSF 61, pressure rated to 400 psi at 73°F and 150 psi at 160°F.
- .4 IPEX AquaRise CPVC Unions to ASTM F1970, NSF 61, pressure rated to 150 psi at 73°F and 57 psi at 160°F.
- .5 IPEX AquaRise CPVC Bronze Threaded Adapters to CSA B137.6, NSF 61, pressure rated to 400 psi at 73°F and 150 psi at 160°F.
- .6 IPEX AquaRise CPVC Repair Couplings to NSF 61, pressure rated to 400 psi at 73°F and 150 psi at 160°F.

2.3 Check Valves

- .1 **Horizontal:** 860KPA (125 psi) / 200 WOG rating, lead free less than 0.25% brass body and certified to NSF/ANSI 61 Annex G and 372, bronze body, swing type metal disc.. Acceptable manufacturers are:

- .1 Toyo Valve Co.;
- .2 Kitz Corporation;

Domestic Water Piping and Valves

- .3 Milwaukee Valve Co.;
- .4 Apollo Valves.
- .2 **Vertical:** bronze, 250 psi WOG rated, lead free and certified to NSF/ANSI 61 Annex G and 372, vertical lift check valve with soldering ends.

2.4 Drain Valves

- .1 Minimum 300 psi water rated, ¾" dia., straight pattern full port bronze ball valves, each complete with a threaded outlet suitable for coupling connection of ¾" dia. garden hose, and a cap and chain. Acceptable manufacturers are:
 - .1 Toyo Valve Co.;
 - .2 Dahl Brothers Canada Ltd.;
 - .3 Kitz Corporation;
 - .4 Apollo Valves;
 - .5 Watts Industries (Canada) Inc..

2.5 Partition Stops

- .1 Equal to Dahl Brothers Canada Ltd. Fig. E2300 Series or equal lead-free partition stops with EDPM packing, slotted spindles, extension tubes, stainless steel access plates, and 3 identified keys.

PART 3 - EXECUTION

3.1 Demolition

- .1 Refer to demolition requirements specified in the mechanical work Section entitled Demolition and Revision Work.

3.2 Piping Installation Requirements

- .1 Provide all required domestic water piping.
- .2 Piping, unless otherwise specified, is to be as follows:
 - .1 for pipe 100 mm (4") dia. and larger inside building and above ground – Schedule 10 stainless steel;
 - .2 for pipe inside building and aboveground in sizes to 100 mm (4") dia., except in vertical shafts – rigid CPVC – IPEX AquaRise. Installer to contact IPEX for training prior to installation of AquaRise;
 - .3 for branch hot and cold piping aboveground from mains and risers to fixtures, fittings, and equipment where fire rated construction is not penetrated – at your option, PEX tubing installed and joined in strict accordance with manufacturer's instructions;
 - .4 for pipe inside building and aboveground in sizes to 100 mm (4") dia. – Type "L" hard copper with solder joints or Type "L" hard copper with pressure coupled mechanical joints.

Domestic Water Piping and Valves

- .3 Slope all piping so that it can be completely drained.
- .4 Provide proper dielectric unions in all connections between copper pipe and ferrous pipe or equipment. Dielectric unions are to conform to ASTM F1545-97 and are to be complete with a thermoplastic liner.

3.3 Installation of Shut-Off and Check Valves

- .1 Refer to Part 3 of the mechanical work Section entitled Basic Mechanical Materials and Methods.

3.4 Installation of Drain Valves

- .1 Provide a drain valve at the bottom of domestic water piping risers, at all other piping low points, and wherever else shown.
- .2 Locate drain valves so that they are easily accessible.

3.5 Installation of Partition Stops

- .1 Provide partition stops in domestic water piping to each group of suite washroom plumbing fixtures. Locate partition stops in piping near floor level in inconspicuous but accessible locations. Confirm exact locations prior to roughing-in.

3.6 Installation of Domestic Hot Water Piping Balancing Valves

- .1 Provide balancing valves in domestic hot water recirculation piping where shown or required. Balancing valves to be provided as follows:
 - .1 Piping up to and including 1": Pressure Independent Balancing Valves
 - .2 Piping greater than 1": Manual Balancing Valves
- .2 Locate each valve such that it is easily accessible.

3.7 Installation of Domestic Hot Water Thermostatic Mixing Valves

- .1 Provide a domestic hot water thermostatic mixing valve assembly and wall mount.
- .2 Adjust each valve to design requirements and check and test operation. Set maximum temperature limit stops.
- .3 Identify each valve and its water temperature delivery setting with an engraved nameplate.

3.8 Flushing and Disinfecting Piping

- .1 Flush and disinfect all new and/or reworked domestic water piping after leakage testing is complete.
- .2 Flush piping until all foreign materials have been removed and the flushed water is clear. Provide connections and pumps as required. Open and close valves, faucets, hose outlets, and service connections to ensure thorough flushing.
- .3 When flushing is complete, disinfect the piping with a solution of chlorine in accordance with AWWA C601.

Domestic Water Piping and Valves

- .4 When disinfecting is complete, submit water samples to a certified laboratory for purity testing and, when testing indicates pure water in accordance with governing standards, submit a copy of the test results and fill the systems.

END OF SECTION

Domestic Water Piping Specialties

PART 1 - GENERAL

1.1 Submittals

- .1 **Shop Drawings/Product Data:** Submit shop drawings/product data sheets for all products specified in Part 2 of this Section.
- .2 **Backflow Preventer Inspection/Test Results:** Submit signed test results and inspection and test log cards for each backflow preventer as specified in Part 3 of this Section.
- .3 **Letter of Pipe Anchor Certification:** Submit a letter from the pipe anchor design engineer to state that the engineer has visited the site to examine the installation of the pipe anchors and that the pipe anchor installation is in accordance with the reviewed anchor shop drawing.

PART 2 - PRODUCTS

2.1 Floor Drain Trap Seal Primers

- .1 **Electronic Type:** Precision Plumbing Products #PT Series surface wall mounting, CSA certified, 115 volt, 1 phase, 60 Hz., electronic, automatic trap priming manifolds, each sized to suit the number of drain traps or interceptors serviced, and each complete with:
 - .1 a galvanized steel cabinet with door;
 - .2 ¾" dia. NPT copper pipe inlet with shut-off valve and water hammer arrestor;
 - .3 a solenoid valve, an atmospheric vacuum breaker, and a discharge manifold with ½" dia. compression type copper tube connections on 1½" centres with quantity to suit the number of items to be primed;
 - .4 a control panel with circuit breaker, 5 ampere fuse, 24 hour timer, and manual override toggle switch.

2.2 Water Hammer Arrestors

- .1 Piston type, sealed, pressurized water hammer arrestors suitable for either horizontal or vertical installation, each complete with a hard drawn copper body, "O"-ring piston seals, an air charge, and an inlet opening equal to diameter of pipe in which arrestor is required.
- .2 Acceptable products are:
 - .1 Zurn #Z1705;
 - .2 Precision Plumbing Products Inc. #SC;
 - .3 Watts Industries (Canada) Inc.;
 - .4 Mifab MWH Series.

2.3 Lavatory Supply Fitting Tempering Valves

Domestic Water Piping Specialties

- .1 Equal to Powers "HydroGuard" Series 490, model LM490 12 mm (½") dia. or model LM491 20 mm (¾") dia. as required, each CSA B125 certified, forged brass, tamper-proof thermostatic mixing valves, adjustable for water supply between 29°C and 49°C (85°F and 120°F), sized to suit number of lavatories in grouping, and complete with a stop and check valve and a lockable handle.
- .2 Each mixing valve is to be complete with a stainless-steel flush wall mounting cabinet with vandal-proof hinged door.

2.4 Air Vents

- .1 Equal to ITT Hoffman Specialty No. 78 cast brass, 150 psi rated, ¾" straight water main vent valves, each tapped at the top for a ⅛" safety drain connection.

PART 3 - EXECUTION

3.1 Installation of Trap Seal Primers

- .1 Provide all required accessible trap seal primers to automatically maintain a water seal in floor drain traps, whether shown on the contract documents or not.
- .2 **Trap Primer Valves:** Provide trap primer valves to prime single or multiple (1 to 6) traps. Install trap primer valves in domestic cold water piping to frequently used plumbing fixtures. Where from 2 to 6 traps are to be primed from the same primer valve, provide the appropriate supply and distribution tube assemblies. Ensure that primer valves are accessible.

3.2 Installation of Shock Absorbers

- .1 Provide accessible shock absorbers in domestic water piping where required.
- .2 Ensure that the size of each shock absorber is properly selected to suit the size of the domestic water pipe and the equipment the pipe is connected to.

3.3 Installation of Water Hammer Arrestors

- .1 Provide accessible water hammer arrestors in domestic water piping in locations as follows:
 - .1 in headers at groups of plumbing fixtures;
 - .2 at the top of risers;
 - .3 at ends of long horizontal runs of piping;
 - .4 in piping connecting solenoid valves or equipment with integral solenoid valves;
 - .5 wherever else required by Code.
- .2 Install each unit in a piping tee either horizontally or vertically in the path of potential water shock in accordance with the manufacturer's published instructions and details.

Domestic Water Piping Specialties

3.4 Installation of Lavatory Supply Fitting Tempering Valves

- .1 Provide thermostatic water tempering valves for hot water supply to public washroom lavatory supply fittings. Conceal valves and piping.
- .2 Provide a flush wall mount panel for each valve. Confirm exact location prior to roughing-in.
- .3 Install in accordance with manufacturer's instructions and set mixing valves to deliver 32°C (90°F) tempered water.

3.5 Installation of Air Vents

- .1 Provide accessible air vents in domestic water piping where required to prevent air binding.
- .2 Extend copper indirect drain piping from the top drain connection of each vent to the nearest suitable drain.
- .3 Locate exact vent locations on as-built record contract documents.

END OF SECTION

Drainage Waste and Vent Piping and Valves

PART 1 - GENERAL

1.1 Submittals

- .1 **Shop Drawings/Product Data:** Submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings.
- .2 **Plumbing Inspection Certificate:** Submit a copy of the plumbing inspection certificate prior to application for Substantial Performance.

PART 2 - PRODUCTS

2.1 Pipe, Fittings and Joints

- .1 **Copper- Solder Joint:** Type DWV hard temper to ASTM B306, with forged copper solder type drainage fittings and 50% silver - 50% tin solder joints.
- .2 **Cast Iron:** Class 4000 cast iron pipe, fittings, and mechanical coupling joints to CAN/CSA B70.
- .3 **Copper-Victaulic Coupling Joint:** Type DWV hard temper to ASTM B306, with factory or site rolled grooved ends (with grooving rolls designed for copper) and Victaulic "Copper Connection" wrought copper or cast bronze fittings and Style 606 gasket type couplings.

PART 3 - EXECUTION

3.1 Demolition

- .1 Refer to demolition requirements specified in the mechanical work Section entitled Demolition and Revision Work.

3.2 Drain and Vent Piping Installation Requirements

- .1 Provide all required drainage and vent piping. Pipe, unless otherwise specified, is to be as follows:
 - .1 for underground pipe inside building and to points 1.5 m (5') outside building lines – rigid PVC sewer pipe, minimum 75 mm (3") dia.;
 - .2 for pipe inside building and aboveground in sizes less than or equal to 65 mm (2-½") dia. – type DWV copper;
 - .3 for pipe inside building and aboveground in sizes greater than or equal to 75 mm (3") dia. – Class 4000 cast iron;
 - .4 for pipe inside building and aboveground in lieu of type DWV copper and cast iron, at your option and where permitted by governing Codes and Regulations – rigid PVC DWV – Equal to IPEX System 15 for low buildings and equal to IPEX System XFR for High Buildings and inside plenums. System 15 shall not be installed inside High Buildings or inside plenums. Installer to contact IPEX for training prior to installation of System 15 or System XFR;

Drainage Waste and Vent Piping and Valves

- .5 for drainage pump discharge pipe connections from pump to and including shut-off and check valve connections – Type "DWV" copper with Victaulic "Copper Connection" fittings and couplings, or Schedule 40 galvanized steel with Victaulic fittings and couplings.
- .2 Unless otherwise specified, slope horizontal drainage piping aboveground in sizes to and including 75 mm (3") dia. 25 mm (1") in 1.2 m (4'), and pipe 100 mm (4") dia. and larger 25 mm (1") in 2.4 m (8').
- .3 Install and slope underground drainage piping to inverts or slopes indicated on drawings to facilitate straight and true gradients between points shown. Verify available slopes before installing pipes.
- .4 Unless otherwise specified, slope horizontal branches of vent piping down to fixture or pipe to which they connect with a minimum pitch of 25 mm (1") in 1.2 m (4').
- .5 Extend vent stacks up through roof generally where shown but with exact locations to suit site conditions and in any case a minimum of 3 m (10') from fresh air intakes. Terminate vent stacks a minimum of 330 mm (13") above roof (including roof parapets) in vent stack covers. Where not shown on drawings, route vent piping from source to building exterior as required in order to satisfy local governing codes and authority. Coordinate vent routing with other building services and ensure there is no architectural impact.
- .6 Provide cast brass dielectric unions at connections between copper pipe and ferrous pipe or equipment.

3.3 Installation of Shut-Off and Check Valves

- .1 Provide a shut-off valve and a check valve in the discharge piping of each drainage pump.
- .2 Locate valves so that they are easily accessible without the use of ladders or other such devices.

END OF SECTION

Drainage and Vent Piping Specialties

PART 1 - GENERAL

1.1 Submittals

- .1 **Shop Drawings/Product Data:** Submit shop drawings/product data sheets for all products specified in this Section.

PART 2 - PRODUCTS

2.1 Cleanouts

- .1 **Horizontal Piping:** TY pipe fitting with an extra heavy brass plug screwed into the fitting.
- .2 **Vertical Piping:** Bronze or copper cleanout tees in copper piping, each complete with a bronze ferrule, and, for cast iron piping, "BARRETT" type cast iron cleanout tees, each gas and water-tight and complete with a bolted cover.
- .3 **Urinal(s):** Wall access cleanout assemblies, each complete with a tapered plug, threaded brass insert, urethane rubber seal, and polished stainless steel access cover with vandal-proof stainless steel securing screw. Acceptable products are:
 - .1 Watts Industries (Canada) Ltd. #CO-440;
 - .2 Zurn #ZSS-1666-1;
 - .3 Jay R. Smith #SQ4-1819;
 - .4 Mifab #C1440-RD.

2.2 Floor Cleanout Terminations

- .1 Factory finished cast iron terminations, each adjustable and complete with a cast iron body with neoprene sleeve, solid, gasketed, polished nickel-bronze scoriated top access cover to suit the floor finish, a seal plug, and captive, vandal-proof, stainless steel securing hardware. Acceptable products are:
 - .1 Watts Industries (Canada) Ltd.;
 - .2 Jay R. Smith Manufacturing Co.;
 - .3 Zurn Industries Ltd.;
 - .4 Mifab Inc.
- .2 All cleanout terminations in areas with a tile or sheet vinyl floor finish are to be as above but with a square top in lieu of a round top.

2.3 Floor Drains, Funnel Floor Drains and Hub Drains

- .1 Unless otherwise specified or scheduled, floor drains and funnel floor drains are to be vandal-proof drains in accordance with the drawing schedule, each complete with a cast iron body and a trap seal primer connection. All cast iron components are to be factory finished with latex based paint coating.
- .2 All floor drains in areas with a tile or sheet vinyl floor finish are to be as above but with a square grate in lieu of a round grate.

Drainage and Vent Piping Specialties

- .1 Acceptable manufacturers are:
 - .1 Watts Industries (Canada) Ltd.;
 - .2 Jay R. Smith Manufacturing Co.;
 - .3 Zurn Industries Ltd.;
 - .4 Mifab Inc.
- .2 Acceptable products are:

PART 3 - EXECUTION

3.1 Installation of Cleanouts

- .1 Provide cleanouts in drainage piping in locations as follows:
 - .1 in the building drain or drains as close as possible to the inner face of the outside wall, and, if a building trap is installed, locate the cleanout on the downstream side of the building trap;
 - .2 at or as close as practicable to the foot of each drainage stack;
 - .3 at maximum 50' intervals in horizontal pipe 4" dia. and smaller;
 - .4 at maximum 100' intervals in horizontal pipe larger than 4" dia.;
 - .5 in the wall at each new urinal or bank of urinals in a washroom;
 - .6 wherever else shown on drawings.
- .2 Cleanouts are to be same diameter as pipe in piping to 100 mm (4") dia., and not less than 100 mm (4") dia. in piping larger than 100 mm (4") dia.
- .3 Where cleanouts in vertical piping are concealed behind walls or partitions, install cleanouts near floor and so cover is within 25 mm (1") of the finished face of the wall or partition.

3.2 Installation of Floor Cleanout Terminations

- .1 Where cleanouts occur in horizontal inaccessible underground piping, extend the cleanout TY fitting up to the floor, and provide a cleanout termination set flush with the finished floor.
- .2 In waterproof floors, ensure that each cleanout termination is equipped with a flashing clamp device. Cleanout terminations are to suit the floor finish.
- .3 Where cleanout terminations occur in finished areas, confirm locations prior to rough-in and arrange piping to suit.
- .4 Ensure that cleanout termination covers in tiled floor are square in lieu of round.

3.3 Installation of Floor Drains, Funnel Floor Drains and Hub Drains

- .1 Provide floor drains, funnel floor drains and hub drains.

Drainage and Vent Piping Specialties

- .2 Coordinate location of floor drains, funnel floor drains and hub drains with equipment provided by Mechanical Division and Owner's supplied equipment. Install in accordance with manufacturer's instructions.
- .3 Equip each drain with a trap.
- .4 In equipment rooms and similar areas, exactly locate floor drains to suit the location of mechanical equipment and equipment indirect drainage piping. In washrooms, exactly locate floor drains to avoid interference with toilet partitions.
- .5 Confirm the exact location of drains prior to roughing in. Where floor drains occur in washrooms coordinate locations with toilet partition installations.
- .6 Temporarily plug and cover floor drains during construction procedures. Remove plugs and covers during final cleanup work and when requested, demonstrate free and clear operation of each drain. Replace any damaged grates, and refinish any areas of the drain where the cast iron finish has been damaged or removed, including rusted areas.

END OF SECTION

Plumbing Fixtures and Fittings

PART 1 - GENERAL

1.1 Submittals

- .1 **Product Data:** Submit product data sheets (fixture cuts) for all plumbing fixtures and fittings, including accessories. All product data sheets must confirm that the proposed fixtures and fittings meet all requirements of this Section of the Specification.

PART 2 - PRODUCTS

2.1 General Re: Plumbing Fixtures and Fittings

- .1 Fixtures and fittings, where applicable, are to be in accordance with requirements of CAN/CSA B45 Series, General Requirements for Plumbing Fixtures, including supplements, ASME A112.1.18.1/CSA B125.1, Plumbing Supply Fittings, and CSA B125.3, Plumbing Fittings.
- .2 Barrier-free fixtures and fittings are to be in accordance with governing Code requirements.
- .3 Unless otherwise specified, vitreous China, porcelain enamelled, and acrylic finished fixtures are to be white.
- .4 Unless otherwise specified, fittings and piping exposed to view are to be chrome plated and polished.
- .5 Fittings located in areas other than private washrooms are to be vandal-proof.
- .6 Fixture carriers are to be suitable in all respects for the fixture they support and construction in which they are located.
- .7 Floor flanges for floor mounted water closets are to be cast iron or brass, secured to floor to prevent movement and complete with a wax seal and brass or stainless steel bolts, nuts, and washers. Plastic floor flanges will not be acceptable.
- .8 Proper seal to mate with fixture carrier flange and produce a water-tight installation.
- .9 Exposed traps for fixtures not equipped with integral traps, such as lavatories, are to be adjustable chrome plated cast brass "P" traps with cleanouts, minimum #17 gauge chrome plated tubular extensions, and chrome plated escutcheons, all to suit fixture type and drain connection.
- .10 Concealed traps for fixtures not equipped with integral traps, such as counter sinks, are to be adjustable cast brass with cleanout plugs, all to suit fixture type and drain connection.
- .11 Exposed supplies for fixtures which do not have supply trim/fittings with integral stops, i.e. lavatories, are to be solid chrome plated brass angle vales with screwdriver stops for public areas, wheel handle stops for private areas, flexible stainless steel risers, and stainless steel or chrome plated steel escutcheons, all arranged and sized to suit fixture.
- .12 Water piping as specified, complete with ball type shut-off valves as specified with water piping, or Dahl Bros. Canada Ltd. ¼ turn Mini Ball Valves.

Plumbing Fixtures and Fittings

2.2 Caulking

- .1 General Electric Series SCS-1200 Silicone Construction Sealant or Dow Corning 780 silicone rubber sealant with primers as recommended by sealant manufacturer. Caulking colour(s) for coloured fixtures other than white, if any, will be selected by Consultant from sealant manufacturer's standard colour range.

PART 3 - EXECUTION

3.1 Demolition

- .1 Refer to demolition requirements specified in Section entitled Demolition and Revision Work.

3.2 Installation of Plumbing Fixtures And Fittings

- .1 Provide required plumbing fixtures and fittings.
- .2 Connect plumbing fixtures and fittings with piping sized in accordance with drawing schedule. Refer to manufacturer's published connection (rough-in) requirements. Where manufacturer requires piping connection larger than shown below, provide piping accordingly:

FIXTURE AND/OR FITTING	DRAIN SIZE MM (IN.)	VENT SIZE MM (IN.)	DHW SIZE MM (IN.)	DCW SIZE MM (IN.)	TEMP WATER SIZE MM (IN.)
Water Closets Flush Valve Type	100 (4)	38 (1-½)	-----	25 (1)	-----
Urinals	75 (3)	38 (1-½)	-----	25 (1)	-----
Lavatories	32 (1-¼)	32 (1-¼)	12 (½)	12 (½)	-----
Lavatories (Electronic Faucet)	32 (1-¼)	32 (1-¼)	12 (½)	12 (½)	12 (½)
Counter Sinks	38 (1-½)	32 (1-¼)	12 (½)	12 (½)	-----
Shower Valves and Heads	-----	-----	12 (½)	12 (½)	12 (½)
Shower Stalls	50 (2)	38 (1-½)	12 (½)	12 (½)	12 (½)
Prefab. Mop Sinks with Drain	75 (3)	38 (1-½)	20 (¾)	20 (¾)	-----
Emergency Eye Wash	-----	-----	-----	-----	12 (½)
Emergency Shower	-----	-----	-----	-----	25 (1)

- .3 Confirm exact location of plumbing fixtures and trim prior to roughing-in. Refer to architectural plan and elevation drawings.

Plumbing Fixtures and Fittings

- .4 When installation is complete, check, and test operation of each fixture and fitting. Adjust or repair as required.
- .5 **Barrier-free fixtures:** Comply with mounting height and other requirements of governing Code(s).
- .6 **Counter Mounted Fixtures and Trim:** Supply templates for counter mounted fixtures and trim and hand to trades who will cut the counter. Ensure openings in counter are properly located.
- .7 **Electronic Lavatory Faucets:** Locate control panels for electronic faucets under lavatories and recessed into wall. Coordinate panel installations with electrical trade who will provide 115 volt power wiring to panels. Install flexible conduit (supplied with box) and extend cord from faucet through the flexible conduit to control box. Connect hot and cold water piping to mixing valve in each box, and tempered water piping from each mixing valve to faucet. Set mixing valve maximum temperature limit stops to 43°C (110°F) after domestic water systems (hot and cold) are complete. Ensure each programmable controller is properly programmed and water off after deactivation is set for 3 seconds.
- .8 For electronic flush valves, locate transformer in ceiling space above electronic units to be served. Coordinate locations with electrical trade who will provide 120 volt line supply to transformers. Provide low voltage wiring from transformers to each electronic flush valve terminal point. Electrical line supply and low voltage wiring is to be concealed and access to transformer must be provided for servicing.
- .9 **Shower Bases:** Protect shower bases from damage during construction and finishing work.
- .10 **Shower Fittings:** Confirm exact mixing valve and shower head locations prior to roughing-in.
- .11 **Refrigerated Drinking Fountains:** Install refrigerated drinking fountains in accordance with manufacturer's instructions. Plug into a wall receptacle provided as part of electrical work. Coordinate receptacle installation with electrical trade on site.
- .12 **Emergency Showers:** Install so bottom of shower head is approximately 2 m (82") above floor, and approximately 400 mm (16") out from the wall. Wall mount mixing valve approximately 1.5 m (5') above floor and adjacent shower head. Set valve temperature limit stop to 35°C (95°F). Ensure valve is open and exposed piping is chrome plated or stainless steel.
- .13 **Emergency Eye Wash Fixtures:** Install eye wash fixtures in accordance with manufacturer's instructions. Ensure exposed piping is painted.
- .14 **Mixing Valves For Emergency Fixtures:** Wall mount mixing valves for emergency fixtures approximately 1.5 m (5') above floor and secure in place. Check and confirm valve operation and temperature of tempered water supply. Provide cabinets. Identify each cabinet and hand 3 identified cabinet keys to Consultant prior to Substantial Performance of the Work.
- .15 **Mop Service Basins:** Set mop service basins on floor over drain piping and connect to roughed-in service. Install wall supply trim and any accessories specified.

Plumbing Fixtures and Fittings

3.3 Caulking at Plumbing Fixtures and Fittings

- .1 Caulk around plumbing fixtures and fittings where they contact walls, floors, and any other building surface.
- .2 Clean areas/surfaces to be caulked and prime in accordance with sealant manufacturer's instructions. Where damage to a building surface may occur, mask surface to prevent damage and ensure a clean exact edge to the caulking bead.
- .3 Apply caulking using a gun with proper size and shape of nozzle and force sealant into joints to ensure good surface contact and a smooth and even finished bead of sealant.
- .4 If joints have been masked sealant may be tooled in a continuous stroke to obtain complete void filling. Remove masking tape immediately after tooling and before sealant begins to skin.

3.4 Dishwasher Connections

- .1 Provide roughed-in water and drain connections for Owner supplied dishwasher consisting of:
 - .1 15 mm (½") dia. domestic hot water connection with a Dahl "Mini-Ball" valve with hose end and water hammer arrestor;
 - .2 40 mm (1-½") dia. DWV copper drain connection with "P" trap and cleanout plug.

3.5 Clothes Washer Connections

- .1 Provide roughed-in water and drain connections for Owner supplied clothes washer consisting of:
 - .1 15 mm (½") dia. piping connection for both hot and cold water, each terminated in a Dahl "Mini-Ball" Valve with hose end and water hammer arrestor;
 - .2 40 mm (1-½") dia. standing waste with a height to suit the washer drain and complete with a "P" trap.

END OF SECTION

Performance Verification Mechanical Piping Systems

PART 1 - GENERAL

1.1 Summary

.1 Related Sections:

- .1 Section 20 05 05 - Common Work Results for Mechanical
- .2 Section 20 05 50 - Testing, Adjusting and Balancing

1.2 References

- .1 Comply with the latest edition of the following Codes and Standards.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 Cleaning & Start-Up of Mechanical Piping Systems

- .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.4 Potable Water Systems

- .1 When cleaning is completed and system filled:
 - .1 Verify performance of equipment and systems as specified elsewhere in Division 23.
 - .2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut off water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.
 - .3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

1.5 Wet & Dry Pipe Sprinkler System, Standpipe & Hose Systems

- .1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Division 23.
- .2 Verification of controls, detection devices, alarm devices is specified Division 26.
- .3 Verify operation of interlocks between HVAC systems and fire alarm systems.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

Ductwork - Standard

PART 1 - GENERAL

1.1 Submittals

- .1 **Shop Drawings/Product Data:** Submit shop drawings/product data sheets for all products specified in this Section except shop fabricated ductwork and fittings.
- .2 **Test Data:** Submit duct leakage test data prior to ductwork being covered from view.

PART 2 - PRODUCTS

2.1 Galvanized Steel Ductwork

- .1 **General:** Galvanized steel sheet is to be hot dipped in accordance with requirements of ASTM A653. Galvanizing for bare uncovered duct to be finish painted is to be G60. All other galvanizing is to be G90.
- .2 **Rectangular:** Lock forming grade hot dip galvanized steel, ASTM A653, shop fabricated, minimum #26 gauge.
- .3 **Round:** Factory machine fabricated, spiral, mechanically locked flat seam, single wall duct, fittings and couplings.
- .4 **Flat Oval:** Factory machine fabricated, single wall, 4-ply spiral lock seam duct, fittings and couplings.

2.2 Flexible Metallic Ductwork

- .1 **Bare:** Spirally wound, semi-rigid, self-supporting corrugated aluminum duct with continuous triple lock seams, SMACNA Form "M-UN", ULC-S110 listed and labelled as a Class 1 Air Duct, constructed of dead soft aluminum strip, and supplied in 3 m (10') lengths.
- .2 **Insulated:** Spirally wound, semi-rigid, self-supporting corrugated aluminum duct with continuous triple lock seams, SMACNA Form "M-I", ULC-S110 listed and labelled as a Class 1 Air Duct, constructed of dead soft aluminum strip, supplied in 3 m (10') lengths and factory covered with 40 mm (1½") thick, 12 kg/m³ (0.75 lb/ft³) density fibreglass insulation with a vinyl jacket meeting flame spread and smoke developed requirements of CAN/ULC-S102.

2.3 Metal Duct System Joint Sealant

- .1 ULC listed and labelled, premium grade, grey colour, water base, non-flammable duct sealer, brush, or gun applied, with a CAN/ULC S102 maximum flame spread rating of 5 and smoke developed rating of 0.

2.4 Acoustic Lining

- .1 Minimum 25 mm (1") thick acoustic lining material meeting NFPA 90A requirements and flame spread and smoke developed fire hazard ratings of CAN/ULC-S102, flexible for round ducts, board type for rectangular ducts, consisting of a bonded fiberglass mat coated on the inside (airside) face with a black fire-resistant coating.

Ductwork - Standard

PART 3 - EXECUTION

3.1 Fabrication and Installation of Galvanized Steel Ductwork

- .1 Provide all required standard galvanized steel ductwork, rectangular and/or round and/or flat oval as shown. **Note** that where rectangular ductwork is shown, round or flat oval ductwork of equivalent cross-sectional area is acceptable.
- .2 Unless otherwise specified, construct and install ductwork in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit the duct pressure class designation of **minimum** 500 Pa (2.0" w.c.) positive or negative as applicable, a maximum velocity of 10 m/s (2000 fpm), and so that the ductwork does not "drum". All flat surfaces of rectangular ductwork are to be cross-broken. Duct system sealing is to meet ANSI/SMACNA Seal Class A requirements.
- .3 **Duct Routing and Dimensions:** Confirm the routing of all ductwork at the site and site measure ductwork prior to fabrication. Note that duct dimensions may be revised to suit site routing and building element requirements, if dimension revisions are reviewed with and approved by the Consultant. Duct routing and/or dimension revisions to suit conditions at the site are not grounds for a claim for an extra cost.
- .4 **Ducts Run Within or Through OWSJ:** Refer to structural drawings. Where ductwork is to be run within or through open web steel joists, note that ductwork shown on the mechanical drawings is schematic only and is to be altered as required to suit the steel joist configuration, spacing, panel points, and cross-bridging at no additional cost.
- .5 **Ductwork Located at Sprayed Fireproofing:** Wherever ductwork is required at locations where sprayed fireproofing is applied to building construction, install the ductwork only after the fireproofing work is complete and do not compromise the fire rating of the sprayed fireproofing.
- .6 **Automatic Control Components:** Install (but do not connect) all duct system mounted automatic control components supplied as part of the automatic control work.
- .7 **Heat Transfer Equipment Connections:** Where indicated, provide duct connections to fan powered heat transfer equipment with integral coils.
- .8 **Separate Hot Water Reheat Coils:** Flange connect ductwork to hot water reheat coils in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. The coils will be suspended independent of connecting ductwork as part of the heat transfer work.
- .9 **Rectangular Duct Support Inside Building:** Support horizontal rectangular ducts inside the building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but use trapeze hangers with, unless otherwise specified, galvanized steel channels, and galvanized steel hanger rods for all ducts that are exposed, and all concealed ducts wider than 500 mm (20").

Ductwork - Standard

- .10 **Round and Flat Oval Duct Support Inside Building:** Support round and flat oval ducts inside the building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but, unless otherwise specified, for both uninsulated and insulated ducts exposed in finished areas, use bands and secure at the top of the duct to a hanger rod, all similar to Ductmate Canada Ltd. type "BA". If the duct is insulated, size the strap to suit the diameter of the insulated duct.
- .11 **Flanged Duct Joints:** Where flanged duct joints are used, do not locate the joints in wall or slab openings, or immediately at wall or slab openings. **Do not use flanged joints for exposed uninsulated ducts in finished areas.**
- .12 **Support of Roof Mounted Ducts:** As specified in the mechanical work Section entitled Duct System Dampers and Accessories.
- .13 **Watertight Ductwork:** Where watertight horizontal ductwork is required, construct the ducts without bottom longitudinal seams. Solder or weld the joints of bottom and side sheets. Seal all other joints with duct sealer. Slope horizontal duct to hoods, risers, or drain points. Provide the drain points. Provide watertight ductwork for:
 - .1 all galvanized steel ductwork outside the building or otherwise exposed to the elements;
 - .2 fresh air intakes;
 - .3 wherever else shown.
- .14 **Application of Sealants:** Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of the sealant.
- .15 **Protective Coating for Exposed Exterior Ducts:** Clean exterior exposed (uninsulated) ducts with a heavy full coverage of Bakor #410-02 black metal paint.
- .16 **Connection of Dissimilar Metal Ducts:** Where dissimilar metal ducts are to be connected, isolate the ducts by means of flexible duct connection material as specified in the Section entitled Duct System Dampers and Accessories.

3.2 Installation Of Acoustic Lining

- .1 Provide acoustic lining in ductwork in locations as follows:
 - .1 wherever shown and/or specified on the drawings;
 - .2 supply ductwork downstream of air terminal boxes for a distance of 2.4 m (8') measured along the duct and outward from the box in all directions;
 - .3 for all transfer air ducts.
- .2 Install lining in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, for all installations regardless of velocity, at leading and trailing edges of duct liner sections, provide galvanized steel nosing channel as per the detail entitled Flexible Duct Liner Installation found in the ANSI/SMACNA manual referred to above.

Ductwork - Standard

3.3 Duct System Protection, Cleaning and Start-Up

- .1 Clean all new ductwork to meet the requirements of the NADCA ACR Standard.
- .2 Temporarily cover all open ends of ducts during construction.
- .3 Vacuum all dirt and foreign matter from the entire duct systems and clean duct system terminals and the interior of air handling units prior to operating fans.
- .4 Prior to starting any supply air handling system provide 50 mm (2") thick glass fibre construction filters at fan equipment in place of permanent filters.
- .5 Provide cheesecloth over all duct system inlets and outlets and run the system for twenty-four hours, after which remove the cheesecloth, the construction filters, and install new permanent filters.
- .6 Include all labour for a complete site walk-through with testing and balancing personnel following the route of all duct systems to be tested, adjusted and balanced for the purpose of confirming the proper position and attitude of dampers, the location of pitot tube openings, and any other work affecting the testing and balancing procedures. Perform all corrective work required as a result of this walk-through.

END OF SECTION

Duct Dampers & Accessories

PART 1 - GENERAL

1.1 Submittals

- .1 **Shop Drawings/Product Data:** Submit shop drawings/product data sheets for all products specified in this Section. Shop drawings and product data sheets must confirm that the products proposed meet all requirements of the Contract Documents.
- .2 **Colour Chart(s):** Submit manufacturer's colour chart(s) for all items for which a finish colour is to be selected.

PART 2 - PRODUCTS

2.1 Round to Rectangular Duct Connections

- .1 Equal to Flexmaster Canada Ltd. galvanized steel, flared, flanged or notched "SPIN-IN" round duct take-off collars with locking dampers in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.2 Splitter Dampers

- .1 Minimum #20 gauge damper blade constructed of the same material as the duct, reinforced as required to suit blade size, system velocity, and to prevent "chatter", and complete with operating hardware equal to Dyn Air Inc. #Q-50 "DYN-A-QUAD S-S" quadrant regulator with RW-50 backup washers to prevent leakage, long square bearing pin, and slide pin.

2.3 Manual Balancing (Volume) Dampers

- .1 Flanged and drilled, single or parallel blade (depending on damper size) manual balancing dampers, each constructed of the same material as the connecting ductwork unless otherwise specified, each designed to maintain the internal free area of the connecting duct, and each complete with:
 - .1 a hexagonal or square shaft extension through the frame;
 - .2 non-stick, non-corrosive synthetic bearings for rectangular dampers, flange stainless steel bearings for round dampers;
 - .3 blade stops for single blade dampers, designed to prevent the blade from moving more than 90°;
 - .4 linkage for multiple blade dampers;
 - .5 a locking hand quadrant damper operator with, for insulated ducts 50 mm standoff mounting.
- .2 **Rectangular Dampers:** Nailor Industries Inc. #SP1010 FF 16G LC BS NS, maximum size 1.2 m x 1.2 m (4' x 4') for a single damper.
- .3 **Round Dampers:** Nailor Industries Inc. #1090 BS, maximum 600 mm (24") diameter, equipped with a minimum 200 mm (8") deep frame, and blade stiffeners where required.

Duct Dampers & Accessories

- .4 **Multiple Rectangular Damper Section Assembly:** Rectangular assembly supplied with the dampers or site constructed, of the same material as the damper and designed for tight and secure mounting of the individual dampers.
- .5 Acceptable manufacturers are:
 - .1 Nailor Industries Inc.;
 - .2 T.A. Morrison & Co. Inc. "TAMCO";
 - .3 Pottorff;
 - .4 Price Industries Ltd.;
 - .5 Ruskin Co.

2.4 Backdraft Dampers

- .1 T. A. Morrison & Co. Inc. "TAMCO" counterbalanced backdraft dampers, Series 7000 WT for vertical mounting, Series 7000 CW for down (horizontal) mounting, 65 mm (2½") deep, sized as shown and complete with:
 - .1 extruded aluminum frame and blades, minimum 1.58 mm (1/16") thick, with captive extruded silicone blade gaskets and side seals in slots integral with the aluminum extrusions;
 - .2 damper blade counterweights internal to the frame and consisting of adjustable weights fastened to brackets which are riveted to the blades;
 - .3 dual PVC linkage tracks at each end of the blades, and non-corrosive linkage with hard alloy aluminum pivot arm and Ticona "Celcon" acetal copolymer bearings.
- .2 Acceptable manufacturers are:
 - .1 T.A. Morrison & Co. Inc. "TAMCO";
 - .2 Nailor Industries Inc.;
 - .3 Pottorff;
 - .4 Price Industries Ltd.;
 - .5 Ruskin Co.

2.5 Fusible Link Dampers

- .1 Curtain blade type, dynamic, galvanized steel (unless otherwise specified) fusible link dampers, ULC classified to Standard CAN/ULC-S112 and in accordance with NFPA 90A requirements, factory tested for closure under airflow, 1 1/2 hour or 3 hour rated as required, and complete with a constant force type 301 stainless steel closure spring, a blade lock assembly, a steel sleeve, retaining angles, and, unless otherwise specified, a 74°C (165°F) rated standard fusible link [100°C (212°F) high temperature fusible link].
- .2 Fusible link dampers are to be Type "B" or Type "C" (as required) with the folded curtain blade out of the air stream except where damper size or location requires the use of type "A" dampers with the curtain blade in the air stream.

Duct Dampers & Accessories

- .3 Fusible link dampers in ductwork other than galvanized steel are to be as specified above but constructed of Type 316 stainless steel.
- .4 Acceptable fusible link damper manufacturers are:
 - .1 Nailor Industries Inc.;
 - .2 Price Industries Ltd.;
 - .3 Pottorff;
 - .4 Ruskin Co.

2.6 Motorized Smoke Dampers

- .1 Fail-safe, opposed blade, galvanized steel (unless otherwise specified) smoke dampers, ULC listed and labelled, leakage Class I smoke rated c/w with smoke detector, normally closed, Type "B" or "C" as required, and complete with a factory installed and tested 115 volt electric actuator to automatically close the damper upon receiving an external signal, and to automatically open the damper when the system is reset, jamb seals, and linkage is to be concealed in the frame, out of the airstream. Smoke dampers are to meet requirements of CAN/ULC-S112.1-10, and NFPA 90A, 92A, and 92B.
- .2 Acceptable products are:
 - .1 Nailor Industries Inc. Series 1210;
 - .2 Greenheck Fan Corp.;
 - .3 Price Industries Ltd.;
 - .4 Pottorff;
 - .5 Ruskin Co.

2.7 Combination Fire/Smoke Dampers

- .1 Model FSD-140 series combination fire smoke damper with 3-V blade, CAN/ULC listed.
- .2 Ratings:
 - .1 Fire Rating: 1½ hours in accordance with CAN/ULC-555.
 - .2 Smoke Rating: Leakage in accordance with CAN/ULC 555S.
 - .3 Elevated Temperature Rating: 350°F (177 °C)
 - .4 Air Flow Rating: 2000 fpm (15.3 m/s)
 - .5 Differential Pressure Rating: 4 in. wg. (1.0 kPa)
- .3 Construction
 - .1 Frame: Hat-shaped channel, roll formed galvanized steel with interlocking gusseted corners. Structurally equivalent to 13 gauge (2.3 mm) U-channel type frame. Low profile head and sill on sizes less than 13 inches (330 mm) high.
 - .2 Blades: 6 inch maximum width x 16 gauge (152 mm x 1.6 mm), 3-V shape, roll formed galvanized steel.

Duct Dampers & Accessories

- .3 Blade Seals: Silicone rubber permanently bonded to blade.
- .4 Jamb Seals: Stainless steel, flexible metal compression type.
- .5 Axles: Minimum ½" (13 mm) diameter plated steel hex-shaped, mechanically attached to blade.
- .6 Bearings: Self-lubricating stainless steel, sleeve-type turning in extruded hole in frame.
- .7 Linkage: Concealed in frame.
- .8 Fire Closure Device: Self-Resettable
- .9 Release Temperature: 74°C (165°F)
- .10 Mounting: Vertical and/or Horizontal (1½ hour rated only)
- .11 Sleeve: Standard 16 inches long x 20 gauge (406 mm x 1.0 mm), factory installed.
- .12 Actuator:
 - .1 Type: Electric 120V, 60 Hz, two-position, fail close.
 - .2 Mounting: External
- .4 Accessories:
 - .1 DRS-30 Two-Temperature Fire Closure Device:
 - .2 UL classified two-temperature device permits the damper to be re-opened after initial temperature closure allowing the damper to remain operable for smoke management purposes until the high temperature limit is reached.
 - .3 Manual damper testing is permitted by physically depressing the low temperature thermal disc from the inside of the damper sleeve and resetting the sensor from the exterior side of the damper sleeve.
 - .4 Dual position blade indicator switch package shall connect directly to the blade axel for positive annunciation (interconnecting arms, wire-forms, or brackets shall not be accepted) and provide full open and full closed blade indication to a remote location.
 - .5 PI-50 Dual Position Indicator Switch Package: Shall connect directly to the blade axel for positive annunciation (interconnecting arms, wire-forms, or brackets shall not be accepted) and provide full open and full closed blade indication to a remote location.
- .5 Acceptable manufacturers are:
 - .1 Nailor Industries Inc.;
 - .2 Greenheck Fan Corp.;
 - .3 Pottorff;
 - .4 Ruskin Co.;
 - .5 Price Industries (E.H. Price).

Duct Dampers & Accessories

2.8 Flexible Connection Material

- .1 Waterproof, indoor-outdoor type flexible connection material meeting requirements of NFPA 90A, consisting of woven glass fibre fabric coated on both sides with synthetic rubber. Acceptable products are:
 - .1 Duro Dyne Canada Inc. "DUROLON";
 - .2 Dyn Air Inc. "HYPALON".

2.9 Duct Access Doors

- .1 In accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, with sizes suitable in all respects for the purpose for which they are provided, and, unless otherwise specified, constructed of the same material as the duct they are associated with.

2.10 Ductwork Drain Points

- .1 Equal to Ductmate Canada Ltd. "DUCTMATE MOISTURE DRAIN", 20 mm ($\frac{3}{4}$ ") diameter moisture drains with galvanized sheet metal funnel, and chrome plated brass threaded drain, nut and cap.

Duct Dampers & Accessories

PART 3 - EXECUTION

3.1 Installation of Round to Rectangular Duct Connections

- .1 Cut round holes in rectangular ducts and provide round to rectangular lock-in fittings with dampers for connection of flexible round ductwork.

3.2 Installation Of Splitter Dampers

- .1 Provide splitter dampers in supply ductwork at branch duct connections off supply air mains, and wherever else shown and/or specified on the drawings. Install splitter dampers so they cannot vibrate and rattle and so that the damper operation mechanisms are in an easily accessible and operable location. Ensure that operators for dampers in insulated ducts are equipped with stand-off mounting brackets.

3.3 Installation of Manual Balancing (Volume) Dampers

- .1 Provide manual balancing dampers in all open end ductwork, in all duct mains, and wherever else shown and/or specified.
- .2 Install the dampers so that the operating mechanism is accessible and positioned for easy operation, and so that the dampers cannot move or rattle. Ensure that operating mechanisms for dampers in insulated ducts are complete with stand-off mounting brackets.
- .3 Confirm exact damper locations with personnel doing air quantity balancing testing work and install dampers to suit. Include for providing five additional dampers at no additional cost.

3.4 Installation of Fusible Link Dampers

- .1 Provide fusible link dampers where shown and/or specified on the drawings. Ensure that the damper rating (1½ or 3 hr.) is suitable for the fire barrier it is associated with.
- .2 Install dampers with retaining angles on all four sides of the sleeve on both sides of the damper and connect with ductwork in accordance with the damper manufacturer's instructions and details to meet Code requirements.
- .3 Provide expansion clearance between the damper or damper sleeve and the opening in which the damper is required. Ensure that the openings are properly sized and located, and that all voids between the damper sleeve and the opening are properly sealed to maintain the rating of the fire barrier.

3.5 Installation of Motorized Smoke Dampers

- .1 Provide motorized smoke dampers where shown and/or specified on the drawings.
- .2 Install dampers with retaining angles on all four sides of each side of the damper, and, where required, connect with ductwork, all in accordance with the damper manufacturer's instructions and details, and Code requirements.
- .3 Coordinate damper installation with the electrical work where electrical connections to damper actuators are specified.

Duct Dampers & Accessories

3.6 Installation of Combination Fire/Smoke Dampers

- .1 Provide combination fire/smoke dampers where shown and/or specified on the drawings and in accordance with manufacturer's ULC approved installation instructions.
- .2 Coordinate damper installation with the electrical work where electrical connections to damper actuators are specified.
- .3 Install dampers square and free from racking with the blades running horizontally. DO NOT compress or stretch damper sleeve or frame into the duct or opening.
- .4 Contractor shall furnish and install duct access door adjacent to dampers for inspection and maintenance. Where duct size permits, install minimum 12 inches x 12 inches (305 mm x 305 mm) duct access doors.
- .5 Handle dampers using the frame or sleeve. Do not lift or move damper using blades, actuator, or jackshaft.
- .6 Install bracing as required on multiple section assemblies to support assembly weight and to hold against system pressure.

3.7 Installation of Flexible Connection Material

- .1 Provide a minimum of 100 mm (4") of flexible connection material where ducts, plenums, and/or easings connect to fans, air handlers and wherever else shown or specified.
- .2 Rigidly secure a minimum of 75 mm (3") of duct material (minimum #24 gauge) to each edge of the flexible fabric and to the fan, duct, plenum, etc., in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Ensure that connections to the flexible fabric material are arranged and supported so as to not impose any external forces on the fabric.

3.8 Installation of Duct Access Doors

- .1 Provide access doors in ductwork for access to all components which will or may need maintenance and/or repair, including reheat coils. Install in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 Identify access doors provided for fusible link damper maintenance with "FLD" stencil painted or marker type red lettering and ensure that the doors are properly located for damper maintenance.
- .3 When requested, submit a sample of proposed duct access doors for review.
- .4 Where sectionalized fusible link dampers and/or balancing dampers are provided in large ducts, provide a plenum type access door to suit, and adequately reinforce the ductwork to suit the access door installed.

3.9 Control Wiring

- .1 Provide all required power wiring for controls from 15A-1P circuits terminated in junction boxes adjacent to the control work and do all control wiring to connect control components.

Duct Dampers & Accessories

- .2 Install wiring in conduit in accordance with electrical work wiring material and installation requirements.

END OF SECTION

Air Terminal Units

PART 1 - GENERAL

1.1 Submittals

- .1 **Shop Drawings/Product Data:** Submit shop drawings/product data sheets for air terminals. Shop drawings/product data sheets must confirm that the proposed air terminals conform to requirements of the Contract Documents. Include the following:
 - .1 capacity and pressure drop;
 - .2 sound power data to verify conformance with specified sound power levels;
 - .3 leakage and dimensions;
 - .4 mounting details to suit locations shown, indicating methods and hardware to be used;
 - .5 control components and a control wiring schematic.
- .2 **Test Report:** Submit with shop drawings/product data, a test report in accordance with ANSI/AMCA Standard 210 requirements and ISO 3741, published test data on DIN (Direct Internal Noise) made by an independent testing agency for 2.5 and 6 m/s (8.2 and 19.7 ft/min) branch velocity or inlet velocity, sound power levels with a minimum inlet pressure of 0.25 kPa (0.036 psi) as per ISO 3741 for the second through seventh octave bands, and confirmation that pressure loss through a silencer will not exceed 60% of inlet velocity pressure maximum.
- .3 **Site Inspection and Start-Up Report:** Submit a site inspection and start-up report from the manufacturer's representative as specified in Part 3 of this Section.

1.2 Quality Assurance

- .1 Air terminals manufacturers are to be current members of the Air-Conditioning, Heating and Refrigeration Institute (AHRI), and the terminals are to be in accordance with requirements of the following standards:
 - .1 AHRI Standard 880, Performance Rating for Air Terminals;
 - .2 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating;
 - .3 International Organization of Standardization (ISO) Standard IS) 3741, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure-Precision Methods for Reverberation Rooms.
- .2 Acceptable manufacturers are:
 - .1 Price Industries Inc.;
 - .2 MetalAire;
 - .3 Titus;
 - .4 Nailor Industries Inc.;
 - .5 Krueger Division of Air System Components Inc.

Air Terminal Units

PART 2 - PRODUCTS

2.1 Fan Powered Variable Air Volume Terminal Boxes

- .1 Variable air volume, pressure independent, fan powered boxes in accordance with drawing schedule, generally as specified for standard variable air volume boxes both complete with a return air fan section.
- .2 Fan section constructed of minimum #22 galvanized steel, internally lined as specified for terminal boxes, and complete with:
 - .1 removable bottom access panel;
 - .2 duct connection collar, and a backdraft damper;
 - .3 direct connected fan-motor assembly, resiliently mounted, and consisting of an overload protected permanent split capacitor motor and a centrifugal, steel, dynamically balanced blower wheel with forward curved blades;
 - .4 solid state controller for adjusting air flow, with an input terminal for remote speed adjustment from a building automation system.
- .3 Galvanized steel attenuators, lined as per box housings, each factory supplied loose and with a length in accordance with drawing schedule.
- .4 For boxes as scheduled, factory tested hot water reheat coils in accordance with drawing schedule, each complete with copper tubes mechanically expanded into plate type aluminum fins, factory mounted in an enclosure insulated with foil faced insulation meeting NFPA 90A and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, and complete with a quick-opening insulated access panel sized and located for coil inspection and maintenance.
- .5 For boxes as indicated, wall mounting thermostat with thermometer and guard, supplied with boxes by box manufacturer, suitable in all respects for box it controls and control sequence, and complete with all required installation and connection accessories.

PART 3 - EXECUTION

3.1 Installation of Terminal Boxes

- .1 Provide ceiling mounted terminal boxes where shown.
- .2 Secure each box in place from the structure by means of galvanized steel angles and hanger rods, independent of connecting ductwork.
- .3 Connect each box with ductwork as indicated. Provide straight inlet duct the same size as the box inlet and of a length equal to a minimum of four duct diameters. Refer to the drawing detail. Co-ordinate final box adjustments and settings with personnel doing system testing and balancing work.
- .4 **Start-Up:** Refer to the Section entitled Common Work Results for Mechanical.

Air Terminal Units

- .5 **Demonstration and Training:** Refer to Section entitled Common Work Results for Mechanical. Include for a one-half day on-site operation demonstration and training session. The training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, and setting and adjusting controls.

END OF SECTION

Diffusers, Registers and Grilles

PART 1 - GENERAL

1.1 Submittals

- .1 **Shop Drawings/Product Data:** Submit shop drawings/product data sheets for grilles and diffusers. Shop drawings/product data is to include capacity, throw and terminal velocity, noise criteria, pressure drops, and all other data to confirm that the products proposed meet all requirements of the Contract Documents.
- .2 **Damper Adjustment Keys:** Supply and hand to the Owner at Substantial Performance, a minimum of ten identified (with tags) grille/diffuser volume control damper adjustment keys.

1.2 Quality Assurance

- .1 Grilles and diffusers are to be tested and performance certified to the Air-Conditioning and Refrigeration Institute Standard ARI 650, Standard for Air Outlets and Inlets.
- .2 Acceptable manufacturers are:
 - .1 Price Industries Inc.;
 - .2 MetalAire;
 - .3 Krueger Division of Air System Components Inc.;
 - .4 Titus;
 - .5 Nailor Industries Inc.;
 - .6 Tuttle & Bailey.

PART 2 - PRODUCTS

2.1 Fire Stop Flaps and Thermal Blanket Material

- .1 Rectangular or round, ULC listed and labelled, blade type galvanized steel fire stop flaps in accordance with CAN4-S112, Fire Test of Fire Damper Assemblies and CAN4-S112.2, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies, each complete with #22 gauge G60 galvanized steel blade(s) and frame, a 74°C (165°F) fusible link, and, for dampers 300 mm (12") and larger, ceramic fibre insulation on both sides of the blades.
- .2 Ceramic fibre material in accordance with CAN/ULC-S102 flame spread and smoke developed criteria and of a thickness to suit the fire rating required.

2.2 Grilles and Diffusers

- .1 Grilles and diffusers of the type, size, capacity, finish, and arrangement as shown on the drawings and as per the drawing schedule, each equipped with all required mounting and connection accessories to suit the mounting location and application.
 - .1 **mounting gasket:** roll type gasket material supplied with the units for site installation on T-bar ceiling members;

Diffusers, Registers and Grilles

PART 3 - EXECUTION

3.1 Installation of Fire Stop Flaps and Thermal Blankets

- .1 Provide fire stop flaps in the duct connection necks of grilles and diffusers installed in ULC fire rated suspended ceiling systems where shown on the drawings.
- .2 Provide thermal blanket material to completely cover grille and/or diffuser pans above suspended ULC fire rated ceilings. Cut, install, and secure in place in accordance with the manufacturer's instructions and ULC requirements.

3.2 Installation of Grilles and Diffusers

- .1 Provide grilles and diffusers where shown on the drawings. Wherever possible, grilles and diffusers are to be the product of one manufacturer.
- .2 Unless otherwise specified connect grilles and diffusers in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .3 Exactly locate grilles and diffusers to conform to the final architectural reflected ceiling plans and detailed wall elevations, and to conform to the final lighting arrangement, ceiling layout, ornamental and other wall treatment.
- .4 Equip supply diffusers having a basic four-way or all round air pattern for operation in one, two, or three way pattern where indicated on the drawings.
- .5 Provide sheet metal plenums, constructed of the same material as the connecting duct, for linear grilles and/or diffusers where shown. Construct and install the plenums in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible. Where individual sections of linear grilles or diffusers are not equipped with a volume control device, equip the duct connection collar(s) with volume control device(s).
- .6 Where linear type diffusers/grilles are installed in suspended T-bar ceilings, clip the diffusers/grilles in place using clip supplied by the diffuser/grille manufacturer.
- .7 Confirm grille and diffuser finishes prior to ordering.

3.3 Supply of Door Grilles

- .1 Supply door grilles as shown and scheduled.
- .2 Hand the grilles to the appropriate trade at the site for installation.

END OF SECTION



Region of Peel
21 Division, Peel Regional Police Facility
Interior Renovation Project

Electrical Specifications

Project Number:

MRK-25008049-A0

Prepared By:

EXP Services Inc.
220 Commerce Valley Drive West, Suite 110
Markham, ON L3T 0A8

Date Submitted:

November 14, 2025

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS

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27 05 00	Common Work Results for Communications	IT	26
27 10 00	Structured Cabling	IT	10

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

Section	Title	Discipline	Pages
28 05 00	Common Work Results for Electronic Safety and Security	S	16
28 10 00	Access Control System	S	35
28 16 00	Intrusion Detection System	S	6
28 20 00	Video Surveillance System	S	18
28 46 00	Fire Detection and Alarm	E	12

END OF DOCUMENT

1 General

1.1 **REFERENCE**

- .1 Division 00 and Division 01 apply to and are a part of each Electrical Division Section.

1.2 **APPLICATION**

- .1 This Section specifies requirements that are common to Electrical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. Where requirements of this Section contradict requirements of Divisions 00 or 01, conditions of Division 00 or 01 to take precedence.
- .2 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section of Electrical Divisions and is to be read accordingly.
- .3 Be responsible for advising product vendors of requirements of this Section.

1.3 **DEFINITIONS**

- .1 "concealed" – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
- .2 "exposed" – means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.
- .3 "finished" - means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.
- .4 "provision" or "provide" (and tenses of "provide") – means supply and install complete.
- .5 "install" (and tenses of "install") – means secure in position, connect complete, test, adjust, verify and certify.
- .6 "supply" – means to procure, arrange for delivery to site, inspect, accept delivery and administer supply of products; distribute to areas; and include manufacturer's supply of any special cables, standard on site testing, initial start-up, programming, basic commissioning, warranties and manufacturers' assistance to Contractor.
- .7 "delete" or "remove" (and tenses of "delete" or "remove") – means to disconnect, make safe, and remove obsolete materials including back boxes and exposed piping and raceways; and patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by Consultant.
- .8 "BAS" – means building automation system; "BMS" – means building management system, "FMS" – means facility management system; and "DDC" means direct digital controls; references to "BAS", "BMS", "FMS" and "DDC" generally mean same.
- .9 "governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and/or "Municipal authority" – means government departments, agencies, standards, rules and regulations that apply to and govern work and to which work must adhere.
- .10 "Mechanical Divisions" - refers to Divisions 20, 21, 22, 23, 25 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.

- .11 "Electrical Divisions" – refers to Divisions 26, 27, 28 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Electrical Contractor, unless otherwise noted.
- .12 "Consultant" – means person, firm or corporation identified as such in Agreement or Documents, and is licensed to practice in Place of the Work, and has been appointed by Owner to act for Owner in a professional capacity in relation to the Work.
- .13 Wherever words "indicated", "shown", "noted", "listed", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to is "indicated", "shown", "listed", or "noted" on Contract Documents.
- .14 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to is "reviewed by", "to the satisfaction of", "submitted to", etc., Consultant.

1.4 DOCUMENTS

- .1 Documents for bidding include but are not limited to issued Drawings, Specifications and Addenda.
- .2 Specification is arranged in accordance with CSI/CSC 50 Division Sections MasterFormat.
- .3 Drawings and Specifications are portions of Contract Documents and identify labour, products and services necessary for performance of work and form a basis for determining pricing. They are intended to be cooperative. Perform work that is shown, specified, or reasonably implied on the drawings but not mentioned in Specification, or vice-versa, as though fully covered by both.
- .4 Review Drawings and Specification in conjunction with documents of other Divisions and, where applicable, Code Consultant's report.
- .5 Unless otherwise specifically noted in Specifications and/or on Drawings, Sections of Electrical Divisions are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and Sections are to be read as a whole.
- .6 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and materials. Any information regarding accurate measurement of building is to be taken on site. Do not scale Drawings, and do not use Drawings for prefabrication work.
- .7 Drawings are intended to convey scope of work and do not show architectural and structural details. Provide fittings, offsets, transformations and similar items required as a result of obstructions and other architectural and/or structural details but not shown on Drawings.
- .8 Locations of equipment and materials shown may be altered, when reviewed by Consultant, to meet requirements of equipment and/or materials, other equipment or systems being installed, and of building, all at no additional cost to Contract.
- .9 Specification does not generally indicate specific number of items or amounts of material required. Specification is intended to provide product data and installation requirements. Refer to schedules, Drawings (layouts, riser diagrams, schematics, details) and Specification to provide correct quantities. Singular may be read as plural and vice versa.

- .10 Starter/ variable frequency drive (VFD) schedule drawings are both mechanical and electrical, and apply to work of Mechanical Divisions and Electrical Divisions. Be responsible for reviewing starter, MCC, VFD, and motor specification requirements of Mechanical Divisions specifications and drawings, prior to Bid submission. Confirm and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.
- .11 Drawings and Specifications are prepared solely for use by party with whom Consultant has entered into a contract and there are no representations of any kind made by Consultant to any other party.
- .12 In case of discrepancies or conflicts between Drawings and Specifications, Documents will govern in order specified in "General Conditions", however, when scale and date of Drawings are same, or when discrepancy exists within Documents, include most costly arrangement.

1.5 **EXAMINATION OF BID DOCUMENTS AND SITE**

- .1 Carefully examine Documents and visit site to determine and review existing site conditions that will or may affect work, and include for such conditions in Bid Price.
- .2 Report to Consultant, prior to Bid Submittal, any existing site condition that will or may affect performance of work as per Documents. Failure to do so will not be grounds for additional costs.
- .3 Upon finding discrepancies in, or omissions from Documents, or having doubt as to their meaning or intent, immediately notify Consultant, in writing.

1.6 **WORK STANDARDS**

- .1 Where any code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction is quoted it means, unless otherwise specifically noted, latest published edition at time of submission of Bids adopted by and enforced by local governing authorities having jurisdiction. Include for compliance with revisions, bulletins, supplementary standards or amendments issued by local governing authorities.
- .2 Where regulatory codes, standards and regulations are at variance with Drawings and Specification, more stringent requirement will apply unless otherwise directed by Consultant.
- .3 Supplementary mandatory Specifications and requirements to be used in conjunction with project include but are not limited to following:
 - .1 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE);
 - .2 American Standards Association (ASA or ANSI);
 - .3 ANSI/ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings;
 - .4 Building Industry Consulting Services, International (BICSI);
 - .5 Canadian Standards Association (CSA);
 - .6 CSA C282, "Emergency Electrical Power Supply For Buildings";
 - .7 CSA Z432, "Safeguarding of Machinery";
 - .8 CSA Z462, "Workplace Electrical Safety";

- .9 Electrical and Electronic Manufacturers Association of Canada (EEMAC);
- .10 Electrical Safety Authority (ESA);
- .11 Electronic Industries Association (EIA);
- .12 Illuminating Engineering Society (IES);
- .13 Institute of Electrical and Electronic Engineers (IEEE);
- .14 National Building Code of Canada (NBC);
- .15 National Electrical Manufacturers Association (NEMA);
- .16 National Fire Protection Association (NFPA);
- .17 Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces";
- .18 Occupational Health and Safety Act (OHSA);
- .19 Ontario Building Code (OBC);
- .20 Ontario Electrical Safety Code (OESC);
- .21 Technical Standards and Safety Authority (TSSA);
- .22 Telecommunications Industry Association (TIA);
- .23 Underwriters' Laboratories of Canada (ULC);
- .24 Material Safety Data Sheets by product manufacturers;
- .25 local utility inspection permits;
- .26 codes, standards, and regulations of local governing authorities having jurisdiction;
- .27 additional codes and standards listed in Trade Sections;
- .28 Owner's standards.
- .4 Provide applicable requirements for barrier free access in accordance with latest edition of local governing building code.
- .5 Where any governing Code, Regulation, or Standard requires preparation and submission of special details or drawings for review they are to be prepared and submitted to appropriate authorities. Be responsible for costs associated with these submittals.
- .6 Unless otherwise specified install, equipment in accordance with equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions.
- .7 Work is to be performed by journeyperson tradesmen who perform only work that their certificates permit, or by apprentice tradesmen under direct on site supervision of experienced journeyperson tradesman. Journeyperson to apprentice ratio is not to exceed ratio determined by the Board as stated in Ontario College of Trades and Apprenticeship Act or local equivalent governing body in Place of the Work.
- .8 Journeyperson tradesmen are to have a copy of valid trade certificates available at site for review by Consultant at any time.
- .9 Experienced and qualified superintendent is to be on-site at times when work is being performed.

- .10 Coordinate work inspection reviews and approvals with governing inspection department to ensure that construction schedule is not delayed. Be responsible for prompt notification of deficiencies to Consultant and submission of reports and certificates to Consultant.
- .11 Properly protect equipment and materials on site from damage due to elements and work of trades, to satisfaction of Consultant. Equipment and materials are to be in new condition upon Substantial Performance of the Work.

1.7 **PERMITS, CERTIFICATES, APPROVALS AND FEES**

- .1 Contact and confirm with local authorities having jurisdiction including utility providers, requirements for approvals from such authorities.
- .2 Submit required applications, plan review, shop drawings, electrical distribution system protection device coordination studies, and short circuit calculations, and any other information requested by local authority.
- .3 Be responsible for ensuring that authorities having jurisdiction which require on-site inspection of work, have ample notification to perform inspection, with sufficient lead time to correct deficiencies in a manner that will not impede schedule of completion of Work.
- .4 Submit to Consultant, approval/inspection certificates issued by governing authorities to confirm that Work as installed is in accordance with rules and regulations of local governing authorities and are acceptable.
- .5 Include in each copy of operating and maintenance instruction manuals, copies of approvals and inspection certificates issued by regulatory authorities.
- .6 Where electromagnetic locks are provided whether by this Division or by others, be responsible for obtaining and paying for required certificates of work with regards to such electromagnetic lock work.

1.8 **REQUIREMENTS FOR CONTRACTOR RETAINED ENGINEERS**

- .1 Professional engineers retained to perform consulting services with regard to Project work, i.e. seismic engineer, fire protection engineer or, structural engineer, are to be members in good standing with local Association of Professional Engineers, and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of governing authorities in Place of the Work.
- .2 Retained engineer's professional liability insurance is to protect Contractor's consultants and their respective servants, agents, and employees against any loss or damage resulting from professional services rendered by aforementioned consultants and their respective servants, agents, and employees in regards to the Work of this Contract.
- .3 Liability insurance requirements are as follows:
 - .1 coverage is to be a minimum of \$1,000,000.00 CDN inclusive of any one occurrence;
 - .2 insurance policy is not to be cancelled or changed in any way without insurer giving Owner minimum thirty days written notice;
 - .3 liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the Place of the Work;
 - .4 Retained consultants are to ascertain that sub-consultants employed by them carry insurance in the form and limits specified above;

- .5 evidence of the required liability insurance in such form as may be required is to be issued to Owner, Owner's Consultant, and Municipal Authorities as required prior to commencement of aforementioned consultant's services.

1.9 **WORKPLACE SAFETY**

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for products where required, and maintain one copy at site in a visible and accessible location available to personnel.
- .2 Comply with requirements of Occupational Health and Safety Act and other regulations pertaining to health and safety, including worker's compensation/ insurance board and fall protection regulations. When working in confined spaces, comply with requirements of Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces" and any other applicable Ministry of Labour requirements.

1.10 **PLANNING AND LAYOUT OF WORK**

- .1 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.
- .2 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions. Generally, order of right of way for services to be as follows:
 - .1 piping requiring uniform pitch;
 - .2 piping 100 mm (4") dia. and larger;
 - .3 large ducts (main runs);
 - .4 cable tray and bus duct;
 - .5 conduit 100 mm (4") dia. and larger;
 - .6 piping less than 100 mm (4") dia.;
 - .7 smaller branch ductwork;
 - .8 conduit less than 100 mm (4") dia..
- .3 As confirmed with Consultant, Mechanical Contractor is to determine final locations of major work within ceiling spaces.
- .4 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify Consultant where headroom or ceiling space appears to be inadequate prior to installation of work.
- .5 Do not use Contract Drawing measurements for prefabrication and layout of raceways, conduits, ducts, bus ducts, luminaires, and other such work. Locations and routing are to be generally in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established bench marks for both horizontal and vertical measurements. Confirm inverts, coordinate with and make allowances for work of other trades. Accurately layout work, and be entirely responsible for work installed in accordance with layout drawings. Where any invert, grade, or size is at variance with Contract Drawings, notify Consultant prior to proceeding with work.

- .6 Prepare plan and interference drawings (at a minimum drawing scale of 1:50 or 1/4"=1' 0") of work for coordination with each trade Contractor. Arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with plan drawings so that trades may make use of section drawings. Section drawings to indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Consultant, engineering drawings for this use. Contractors' interference drawings are to be distributed among other Trade Contractors. Submit drawings to Consultant for review. Failure of General Contractor to prepare and coordinate overall interface drawings of trades does not relieve respective Division Contractor of responsibility to ensure that work is properly planned and coordinated.
- .7 Carry out alterations in arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with Contract Documents, in order to conceal work behind finishes, or to allow installation of other work, without additional cost. In addition, make necessary alterations in other work required by such alterations, without additional cost.
- .8 Control products, products requiring maintenance, junction boxes, and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.
- .9 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were missed due to lack of coordination.
- .10 Where drawings indicate that acoustic tile ceiling is being suspended below plaster ceiling, coordinate design of framework used to support suspended ceiling, lighting, diffusers, and other Divisions components that are mounted within or through ceiling. Do not mount devices to suspended ceiling. Secure and mount to ceiling slab above. Seal ceiling openings to maintain required fire rating.

1.11 **PHASING**

- .1 Include for scheduling, co-ordination, and construction phasing to suit project as specified in Division 01 and on drawings. Confirm exact phasing requirements with Consultant prior to start of Work.

1.12 **COORDINATION OF WORK**

- .1 Review Contract Documents and coordinate work with work of each trade. Coordination requirements are to include, but not be limited to following:
 - .1 requirements for openings, sleeves, inserts and other hardware necessary for installation of work;
 - .2 concrete work such as housekeeping pads, sumps, bases, etc., required for work, and including required dimensions, operating weight of equipment, location, etc.;
 - .3 depth and routing of excavation required for work, and requirements for bedding and backfill;
 - .4 wiring work required for equipment and systems but not specified to be done as part of mechanical work, including termination points, wiring type and size, and any other requirements.

- .2 Ensure materials and equipment are delivered to site at proper time and in such assemblies and sizes so as to enter into building and be moved into spaces where they are to be located without difficulty.
- .3 Wherever possible, coordinate equipment deliveries with manufacturers and/or suppliers so equipment is delivered to site when it is required, or so it can be stored within building subject to available space as confirmed with Owner and protected from elements.
- .4 Ensure proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Comply with code requirements with regards to access space provision around equipment. Remove and replace any equipment which does not meet this requirement.
- .5 Where work is to be integrated, or is to be installed in close proximity with work of other trades, coordinate work prior to and during installation.

1.13 **COMPONENT FINAL LOCATIONS**

- .1 Owner and Consultant reserve right to relocate electrical components such as receptacles, switches, communication system, outlets, hard wired outlet boxes and luminaries at a later date, but prior to installation, without additional cost to Owner, if relocation per components do not exceed 3 m (10') from original location. No credits will be anticipated where relocation per components of up to and including 3 m (10') reduces materials, products and labour. Should relocations exceed 3 m (10') from original location, adjust contract price for that portion beyond 3 m (10') in accordance with provisions for changes in Contract Documents.

1.14 **SYSTEMS COORDINATION**

- .1 Be responsible for and perform specific coordination of various low voltage systems supplied by Electrical Divisions and also with systems supplied by other Divisions of Work. Include for but not be limited to provision of following, as applicable:
 - .1 coordinate with General Contractor and other Subcontractors, various systems of trades which in any way are interfaced with or monitored by or integrated to, or need to be coordinated with;
 - .2 prepare systems coordination drawings detailing related system coordination and integration points being monitored and/or controlled; submit coordination drawings as part of shop drawing submission;
 - .3 coordinate security system requirements with successful door hardware supplier and prepare detailed coordination drawings of component installations, wiring and conduit layouts, division of responsibility between various trades, etc.; review security system requirements with associated door hardware (electromagnetic locks, electric strikes, etc.), to ensure proper sequence of operation and door functionality is provided to suit each door configuration; prepare detailed door functionality of each door configuration and submit for review by Consultant;
 - .4 review systems requirements for component back boxes and conduits; ensure that system of conduits and boxes meet respective system wiring bending radii requirements;
 - .5 review specifications of each trade/Division (i.e. for BAS points, elevator requirements, electrical devices in millwork or prefabricated service consoles, outlet box and back box requirements), to ensure proper power supplies, interconnecting wiring requirements and back box/ outlet box requirements;

- .6 review with manufacturers coordination and integration requirements of their systems;
- .7 review each systems communication protocols to ensure they are compatible and can communicate with each other as required;
- .8 review system shop drawings prior to submission to Consultant, to verify that each system has been coordinated with other systems and that required options and features are selected to meet coordination requirements;
- .9 be present at testing and commissioning functions of each system and provide technical assistance with regards to system operations;
- .10 be "on-site" coordinator of respective system trades with regards to respective system coordination of installation and testing;
- .11 coordinate with Consultant with regards to ensuring that systems coordinate and integrate properly to satisfaction of Owner;
- .12 document coordination and integration requirements and maintain records for submission as part of shop drawings;
- .13 respond to coordination and integration requirements and be responsible for such work;
- .14 where a system integrator has been included for, coordinate integration requirements with system integrator.

1.15 **PRODUCTS**

- .1 Be responsible for ordering of products (equipment and materials) in a timely manner in order to meet project-scheduling timelines. Failure to order products to allow manufacturers sufficient production/delivery time to meet project-scheduling timelines is an unacceptable reason to request for other suppliers or substitutions.
- .2 Provide Canadian manufactured products wherever possible or required and when quality and performance is obtainable at a competitive price. Products are to be supplied from manufacturer's authorized Canadian representative, unless otherwise noted. Unless otherwise specified, products are to be new and are to comply with applicable respective Canadian standards. References to UL listings of products to include requirements that products are to be also Underwriters Laboratories of Canada (ULC) listed for use in Canada. Products are to meet or exceed latest ANSI/ASHRAE/IES 90.1 standards, as applicable. Do not supply any products containing asbestos materials or PCB materials.
- .3 Systems and equipment of this Project are to be "State of the Art" and be most recent and up to date series/version of product that is available at time of shop drawing review process. Products that have been stored or "on shelf" for an extended period of time will not be accepted. Software is to be of latest version available and be provided with updates available at time of shop drawing review process. Systems are to be designed such that its software is backwards compatible. Future upgrades are not to require any hardware replacements or additions to utilize latest software.
- .4 Products scheduled and/or specified have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for any product specified by manufacturer's name and model number. Where acceptable manufacturers are listed, first name listed is base specified company. Bid Price may be based on products supplied by any of manufacturers' base specified or named as acceptable for particular product. If acceptable manufacturers are not stated for a particular product, base Bid Price on product supplied by base specified manufacturer.

- .5 Documents have been prepared based on product available at time of Bidding. If, after award of Contract, and if successful manufacturer can no longer supply a product that meets base specifications, notify Consultant immediately. Be responsible for obtaining other manufacturers product that complies with base specified performance and criteria and meets project timelines. Proposed products are subject to review and consideration by Consultant and are considered as substitutions subject to a credit to Contract. In addition, if such products require modifications to room spaces, mechanical systems, electrical systems, etc., include required changes. Such changes are to be submitted in detail to Consultant for review and consideration for acceptance. There will be no increase in Contract Price for revisions. Above conditions supplement and are not to supersede any specification conditions in Division 01 with regards to substitutions or failure to supply product
- .6 Listing of a product as "acceptable" does not imply automatic acceptance by Consultant and/or Owner. It is responsibility of Contractor to ensure that any price quotations received and submittals made are for products that meet or exceed specifications included herein.
- .7 If products supplied by a manufacturer named as acceptable are used in lieu of base specified manufacturer, be responsible for ensuring that they are equivalent in performance and operating characteristics (including energy consumption if applicable) to base specified products. It is understood that any additional costs (i.e. for larger starters, larger feeders, additional spaces, etc.), and changes to associated or adjacent work resulting from provision of product supplied by a manufacturer other than base specified manufacturer, is included in Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of base specified equipment and dimensions of such equipment differs from base specified equipment, prepare and submit for review accurately dimensioned layouts of rooms affected, identifying architectural and structural elements, systems and equipment to prove that equipment in room will fit properly meeting design intent. There will be no increase in Contract Price for revisions.
- .8 In addition to manufacturer's products base specified or named as acceptable, other manufacturers of products may be proposed as substitutions to Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products base specified or named as acceptable. Certify in writing to Consultant that proposed substitution meets space, power, design, energy consumption, and other requirements of base specified or acceptable product. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of proposed substitution. Consultant has sole discretion in accepting any such proposed substitution of product.
- .9 Where products are listed as "or approved equal", certify in writing that product to be used in lieu of base specified product, at least meets space, power, design, energy consumption, and other requirements of base specified product and is equivalent or better than base specified product. When requested by Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or approved equal" products is at sole discretion of Consultant. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of approved equal product. There must be no increase in Contract price due to Consultant's rejection of proposed equivalent product.

- .10 Whenever use of product other than base specified product is being supplied, ensure corresponding certifications and product information (detailed catalogue and engineering data, fabrication information and performance characteristics) are submitted to Consultant for review. Failure of submission of these documents to Consultant in a timely manner to allow for review will result in base specified product to be supplied at Consultant's discretion, at no additional cost to Contract.
- .11 Products supplied by a manufacturer/supplier other than a manufacturer listed as acceptable may be considered for acceptance by Consultant if requested in writing with full product documentation submitted, a minimum of 10 working days prior to Bid closing date.
- .12 Any proposed changes initiated by Contractor after award of Contract may be considered by Consultant at Consultant's discretion, with any additional costs for such changes if approved by Consultant, and costs for review, to be borne by Contractor.
- .13 Whenever use of product other than based specified products or named as acceptable is being supplied, allow sufficient time for processing of product submissions and time for Consultant's review, such that there will not be significant impact on contract time or work schedule.
- .14 Requirements for low voltage systems of this project that are of technology that changes rapidly and are forever evolving and changing, resulting in systems that may be out dated by time of installation, are to include provisions to allow Owner option to select most updated technology. Shop drawings for such systems and equipment are to include provisions for a minimum 6-week review time for Owner to review degree of technology of each system and determine acceptance. Owner will have right to substitute a more advanced technology subject to negotiated pricing.

1.16 **SHOP DRAWINGS**

- .1 At start-up meeting confirm with Consultant, products to be included in shop drawing submission. Prepare and submit list of products to Consultant for review.
- .2 Submit electronic copies of shop drawings unless otherwise directed by Consultant. Confirm exact requirements with Consultant.
- .3 Submit for review, drawings showing in detail design, construction, and performance of equipment and materials as requested in Specification. Include minimally for preparation and submission of following, as applicable:
 - .1 product literature cuts;
 - .2 equipment data sheets;
 - .3 equipment dimension drawings;
 - .4 system block diagrams;
 - .5 sequence of operation;
 - .6 connection wiring schematic diagrams;
 - .7 functionality with integrated systems.
- .4 Each shop drawing or product data sheet is to be properly identified with project name and product drawing or specification reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.
- .5 Where any item of equipment is required by Code or Standard or By-Law to meet a specific energy efficiency level, or any other specific requirement, ensure this requirement is clearly indicated on submission.

- .6 Ensure proposed products meet each requirement of Project. Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS". Include company name, submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated and signed will be returned to be resubmitted.
- .7 Consultant to review shop drawings and indicate review status by stamping shop drawing copies as follows:
 - .1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) – If Consultant's review of shop drawing is final, Consultant to stamp shop drawing;
 - .2 "RETURNED FOR CORRECTION" – If Consultant's review of shop drawing is not final, Consultant to stamp shop drawing as stated above, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant's notations and resubmit.
- .8 Following is to be read in conjunction with wording on Consultant's shop drawing review stamp applied to each and every shop drawing submitted:

"THIS REVIEW BY CONSULTANT IS FOR SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH GENERAL DESIGN CONCEPT. THIS REVIEW DOES NOT MEAN THAT CONSULTANT APPROVES DETAILED DESIGN INHERENT IN SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH CONTRACTOR. CONSULTANT'S REVIEW DOES NOT RELIEVE CONTRACTOR OF RESPONSIBILITY FOR ERRORS OR OMISSIONS IN SHOP DRAWINGS OR OF CONTRACTOR'S RESPONSIBILITY FOR MEETING REQUIREMENTS OF CONTRACT DOCUMENTS. BE RESPONSIBLE FOR DIMENSIONS TO BE CONFIRMED AND CORRELATED AT JOB SITE, FOR INFORMATION THAT PERTAINS SOLELY TO FABRICATION PROCESSES OR TO TECHNIQUES OF CONSTRUCTION AND INSTALLATION, AND FOR CO-ORDINATION OF WORK OF SUB-TRADES."
- .9 Submit each system and each major component as separate shop drawing submissions. Submit together, shop drawings for common devices such as devices of each system.
- .10 Obtain shop drawings for submission from product manufacturer's authorized representatives and supplemented with additional items specified herein.
- .11 Do not order product until respective shop drawing review process has been properly completed by Consultant.
- .12 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.
- .13 Refer to specific requirements in other Sections.

1.17 **EQUIPMENT LOADS**

- .1 Supply equipment loads (self-weight, operating weight, housekeeping pad, inertia pads, etc.) to Consultant, via shop drawing submissions, prior to construction.
- .2 Where given choice of specific equipment, actual weight, location and method of support of equipment may differ from those assumed by Consultant for base design. Back-check equipment loads, location, and supports, and include necessary accommodations.
- .3 Where supporting structure consists of structural steel framing, it is imperative that equipment loads, location, and method of support be confirmed prior to fabrication of structural steel. Be responsible for confirming locations of equipment with Consultant prior to construction.

1.18 **OPENINGS**

- .1 Supply opening sizes and locations to Consultant to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.
- .2 No openings are permitted through completed structure without written approval of Consultant. Show required openings on a copy of structural drawings. Identify exact locations, elevations, and size of proposed openings and submit to Consultant for review, well in advance of doing work.
- .3 Prior to leaving site at end of each day, walk through areas of work and check for any openings, penetrations, holes, and/or voids created under scope of work of project, and ensure that any openings created under scope of work have been closed off, fire-stopped and smoke-sealed. Unless directed by Owner and coordinated with Consultant, do not leave any openings unprotected and unfinished overnight.

1.19 **SCAFFOLDING, HOISTING, AND RIGGING,**

- .1 Unless otherwise specified or directed, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval of Consultant.
- .2 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.
- .3 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from Consultant.

1.20 **CHANGES IN THE WORK**

- .1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity, or type of any work from that required by Contract Documents, prepare and submit to Consultant for approval, a quotation being proposed cost for executing change or revision.
- .2 Quotation to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.
- .3 If overhead and profit percentages are not specified in Division 00 or 01, but allowable under Contract as confirmed with Consultant prior to contract signing, then allowable maximum percentages for overhead and profit are to be 7% and 5% respectively.
- .4 Unless otherwise specified in Divisions 00 or 01, following additional requirements apply to quotations submitted:
 - .1 when change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work;
 - .2 material costs are not to exceed those published in local estimating price guides;
 - .3 electrical material labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labor Units at normal level;
 - .4 costs for journeyman and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work;
 - .5 cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision, and change or revision must be such that site superintendent's involvement is necessary;

- .6 costs for rental tools and/or equipment are not to exceed local rental costs;
 - .7 overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals;
 - .8 quotations, including those for deleted work, to include a figure for any required change to Contract time.
- .5 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.
- .6 Make requests for changes or revisions to work to Consultant in writing and, if Consultant agrees, will issue Notice of Change.
- .7 Do not execute any change or revision until written authorization for change or revision has been obtained from Consultant.

1.21 **PROGRESS PAYMENT BREAKDOWN**

- .1 Prior to submittal of first progress payment draw, submit a detailed breakdown of work cost to assist Consultant in reviewing and approving progress payment claims.
- .2 Payment breakdown is subject to Consultant's approval and progress payments will not be processed until an approved breakdown is in place. Breakdown is to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including system testing and verification, and project closeout submittals.
- .3 Indicate equipment, material and labour costs for site services (if applicable) and indicate work of each trade in same manner as they will be indicated on progress draw.

1.22 **NOTICE FOR REQUIRED FIELD REVIEWS**

- .1 Whenever there is a requirement for Consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 5 working days' notice in writing to Consultant.
- .2 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.
- .3 Do not conceal work until Consultant advises that it may be concealed.
- .4 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

1.23 **PRELIMINARY TESTING**

- .1 When directed by Consultant, promptly arrange, pay for, and perform site tests on any piece of equipment or any system for such reasonable lengths of time and at such times as may be required to prove compliance with Specification and governing Codes and Regulations, prior to Substantial Performance of the Work.
- .2 When, in Consultant's opinion, tests are required to be performed by a certified testing laboratory, arrange and pay for such tests.

- .3 These tests are not to be construed as evidence of acceptance of work, and it is agreed and understood that no claim for delays or damage will be made for injury or breakage to any part or parts of equipment or system due to test where such injuries or breakage were caused by faulty parts and/or workmanship of any kind.
- .4 When, in Consultant's opinion, tests indicate that equipment, products, etc., are defective or deficient, immediately remove such equipment and/or products from site and replace them with acceptable equipment and/or products, at no additional cost.

1.24 **PROVISIONS FOR SYSTEMS/EQUIPMENT USED DURING CONSTRUCTION**

- .1 Any system or piece of equipment that is specified to be provided under requirements of Documents and is required to be used during construction stages of work prior to issuing of Certificate of Substantial Performance of the Work, are to be provided with special interim maintenance and service to cover systems/equipment during time of use during construction period of project until project has been certified as substantially performed and such systems/equipment are turned over to Owner.
- .2 During this period of construction, such systems/equipment to not become property of Owner or be Owner's responsibility for maintenance or service. Systems/equipment are to remain property of respective manufacturers/suppliers or Contractor, who are responsible for full maintenance and servicing of systems/equipment in order to maintain validity of warranties after turn over to Owner.
- .3 Prior to application for a Certificate of Substantial Performance of the Work and turn over to Owner, such systems/equipment to be cleaned, restored to "new" condition, luminaries re-lamped with "new" lamps, genset "serviced", paint finishes "touched-up", filters cleaned or replaced, etc.

1.25 **TEMPORARY SERVICES**

- .1 Coordinate with General Contractor, requirements for temporary services including but not limited to temporary electrical power, lighting and exit pathways. Locations of exit pathways to be as decided at discretion of General Contractor, and to be illuminated complete with emergency lighting, and provided with exit signage and fire alarm devices in accordance with requirements of local governing building code and local governing inspection authorities.

1.26 **CLEANING**

- .1 During construction, keep site reasonably clear of rubbish and waste material resulting from work on a daily basis to the satisfaction of Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove rubbish and debris, and be responsible for repair of any damage caused as a result of work.
- .2 At time of final cleaning, clean luminaire reflectors, lenses, and other luminary surfaces that have been exposed to construction dust and dirt, including top surface, whether it is exposed or in ceiling space.
- .3 Clean switches, receptacles, communications outlets, coverplates, and exposed surfaces.
- .4 Clean other electrical equipment and devices installed as part of this project.
- .5 For work performed in electrical equipment rooms, electrical closets and communication closets, perform following:

- .1 HEPA vacuum and clean interiors and buswork of switchboards, panels, cabinets and other electrical equipment of construction debris and dust prior to energization;
- .2 HEPA vacuum top of switchboards, panels, cabinets, bus ducts, cable trays and conduits in room, followed by a thorough HEPA vacuuming of floors;
- .3 do not lay permanent switchboard matting in electrical rooms until rooms are re-cleaned, and floors wet mopped and dried just prior to final turn over to Owner.

1.27

RECORD AS-BUILT DRAWINGS

- .1 Drawings for this project have been prepared on a CAD system using AutoCAD software of release version confirmed with Consultant. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from Consultant. Drawings may also to be used for preparation of layouts and interference drawings.
- .2 As work progresses at site, clearly mark in red in a neat and legible manner on a set of bound white prints of Contract Drawings, changes and deviations from routing of services and locations of equipment shown on Contract Drawings, on a daily basis. Changes and deviations include those made by addenda, change orders, and site instructions. Use notes marked in red as required. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep set up-to-date, and ensure set is available for periodic review. As-built set is also to include following:
 - .1 dimensioned location of inaccessible concealed work;
 - .2 locations of control devices with identification for each;
 - .3 location and identification of devices in concealed locations such as accessible ceiling spaces and raised floors;
 - .4 for underground piping and ducts, record dimensions, invert elevations, offsets, fittings, cathodic protection and accessories if applicable, and locate dimensions from benchmarks to be preserved after construction is complete;
 - .5 location of concealed services terminated for future extension and work concealed within building in inaccessible locations.
 - .6 location of fire alarm devices and include addresses of devices; identify fire alarm zones;
 - .7 identify routing and location of concealed conduits/ducts of diameter 50 mm (2") and greater;
- .3 Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of Contract Drawing set in accordance with marked up set of "as-built" white prints including deviations from original Contract Drawings, thus forming an "as-built" drawing set. Submit "as-built" site drawing prints to Consultant for review. Make necessary revisions to drawings as per Consultant's comments, to satisfaction of Consultant.
- .4 Use final reviewed "as-built" drawing set to provide CAD files of drawings thus forming true "as-built" set of Contract Drawings. Identify set as "Project Record Copy". Load digital copies of final reviewed by Consultant as-built drawings onto USB type flash drive. Provide 2 complete sets of "as-built" drawings on separate USBs. Submit "as-built" sets of white prints and USBs to Consultant.
- .5 Submitted drawings are to be of same quality as original Contract Drawings. CAD drawing files are to be compatible with AutoCAD software release version confirmed with Consultant.

- .6 Unless otherwise noted in Divisions 00 or 01, failure to maintain accurate record drawings will incur additional 5% holdback on progress claims until drawings are brought up to date to satisfaction of Consultant.
- .7 Prepare and submit for review with record drawings, a neat, clear, properly identified, "as-built" electrical distribution riser diagram record drawing (in AutoCAD format release version confirmed with Consultant) of entire electrical distribution system up to and including line side connections to panelboards. Building and room outlines are to reflect "as-built" outlines. Include in diagrams for feeder types and sizes, conduit sizes, breaker, switchboard and distribution panel sizes, etc. Submit sample version to Consultant for review and comments prior to final manufacturer. Size diagrams same size as issued full Size Drawings. Mount riser diagrams on 10 mm (3/8") thick foam core complete with mylar finish cover, and hardware suitable for wall mounting in main electrical room.
- .8 Include on single lines, panelboard locations identified by room numbers below panel. When specific identified location is not available, nearest available room number to be used followed by a (Δ) triangle to flag approximate location. Encircle various loads by Building Wings (where applicable) for ease of identification. Group lighting loads on panelboards on top of panel. Identify motor control centres and splitters similar to panelboards. Identify fuse sizing including existing equipment where there is no difficulty in obtaining information. Use these requirements for pricing, and confirm exact requirements with Consultant prior to commencing work.

1.28 **OPERATING AND MAINTENANCE MANUALS**

- .1 Submit draft copy to Consultant for review. Incorporate any Consultant's comments in preparation final manuals.
- .2 For each item of equipment for which a shop drawing is required (except for simple equipment), supply minimum 3, project specific, indexed copies of equipment manufacturers' operating and maintenance (O&M) instruction data manuals. Confirm exact quantity of manuals with Consultant. Consolidate each copy of data in an identified hard cover three "D" ring binder. Each binder to include:
 - .1 front cover: project name label; wording – "Electrical Systems Operating and Maintenance Manual"; and date;
 - .2 introduction sheet listing Consultant, Contractor, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses;
 - .3 equipment manufacturer's authorized contact person name, telephone number and company website;
 - .4 Table of Contents sheet, and corresponding index tab sheets;
 - .5 copy of each "REVIEWED" or clean, updated "REVIEWED AS NOTED" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, company website address, and email address for local source of parts and service; when shop drawings are returned marked "REVIEWED AS NOTED" with revisions marked on shop drawing copies, they are to be revised by equipment supplier to incorporate comments marked on "reviewed" shop drawings and a clean updated copy is to be included in operating and maintenance manuals;
 - .6 Maintenance data is to include:
 - .1 operation and trouble-shooting instructions for each item of equipment and each system;
 - .2 schedules of tasks, frequency, tools required, and estimated task time;

- .3 recommended maintenance practices and precautions;
- .4 complete parts lists with numbers.
- .7 Performance data is to include:
 - .1 equipment and system start-up data sheets;
 - .2 equipment test reports;
 - .3 final verification and commissioning reports.
- .8 explanation of operating principles and sequences;
- .9 inspection certificates issued by regulatory authorities;
- .10 wiring and connection diagrams;
- .11 copies of additional and revised panelboard directories;
- .12 warranties;
- .13 items requested specifically in Section Articles.
- .3 Generally, binders are not to exceed 75 mm (3") thick and not to be more than 2/3 full.
- .4 Operating and maintenance instructions are to relate to job specific equipment supplied under this project and related to Owner's building. Language used in manuals is to contain simple practical operating terms and language easy for in-house maintenance staff to understand how to operate and maintain each system.
- .5 Before applying for a Certificate of Substantial Performance of the Work, assemble one copy of O & M Manual and submit to Consultant for review prior to assembling remaining copies. Incorporate Consultant's comments into final submission.
- .6 Provide 2 digital copies of contents of operating and maintenance manuals and load onto separate USB type flash drives and submit to Consultant. Prepare digital copies using version of Adobe Acrobat Portable Document Format or equal as confirmed with Consultant and enhanced with bookmarks and internal document links.

1.29 **COMMISSIONING**

- .1 Commissioning Agent is appointed by Owner to oversee commissioning activities of contract.
- .2 Interface, cooperate and coordinate with Commissioning Agent and attend commissioning meetings. Perform commissioning activities for aspects of work provided in Electrical Divisions and perform corrective work identified by Commissioning Agent.
- .3 Submit copies of submittals such as O&M manuals, shop drawings, schedules and test reports of systems and equipment to Commissioning Agent, prior to start of commissioning activity or as directed by Commissioning Agent.
- .4 Commissioning Agent may also be present for any testing/commissioning activities. Notify Commissioning Agent in advance of these activities.
- .5 Refer to Division 01 for additional commissioning requirements. Refer to Section entitled Electrical Work Commissioning for additional requirements.
- .6 Where commissioning specifications are included as part of Division 01, requirements of Section entitled Electrical Work Commissioning are to supplement commissioning requirements of Division 01. Where variances or contradictions exist, more stringent requirement will apply unless otherwise directed by Consultant.

1.30 **PROJECT CLOSE OUT SUBMITTALS**

- .1 Prior to application for Substantial Performance of the Work, submit required items and documentation specified, including following:
 - .1 Operating and Maintenance Manuals;
 - .2 as-built record drawings and associated data;
 - .3 extended warranties for equipment as specified;
 - .4 operating test certificates;
 - .5 final commissioning report;
 - .6 identified keys for equipment and/or panels for which keys are required, and other items required to be submitted;
 - .7 other data or products specified.
- .2 Submit two (2) USB key of entire final closeout documents including As-builts CAD files and PDFs and (2) hard copy sets of entire close-out documents including As-builts drawings to Client Office.

1.31 **INSTRUCTIONS TO OWNER**

- .1 Refer to equipment and system operational and maintenance training requirements specified in Division 01.
- .2 Train Owner's designated personnel in aspects of operation and maintenance of equipment and systems as specified. Demonstrations and training are to be performed by qualified technicians employed by equipment/system manufacturer/supplier. Supply hard copies of training materials to each attendee.
- .3 Unless where specified otherwise in trade Sections, minimum requirements are for manufacturer/suppliers of each system and major equipment, to provide minimum two separate sessions each consisting of minimum 4 hours on site or in factory training (at Owner's choice), of Owner's designated personnel (for up to 6 people each session), on operation and maintenance procedures of system.
- .4 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Use Operating and Maintenance Manuals during training sessions. Training modules include but are not limited to:
 - .1 Operational Requirements and Criteria: equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations;
 - .2 Troubleshooting: diagnostic instructions, test and inspection procedures;
 - .3 Documentation: equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like;
 - .4 Maintenance: inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools;
 - .5 Repairs: diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.

- .5 Before instructing Owner's designated personnel, submit to Consultant for review preliminary copy of training manual and proposed schedule of demonstration and training dates and times. Incorporate Consultant's comments in final copy.
- .6 Obtain in writing from Consultant, list of Owner's representatives to receive instructions. Submit to Consultant prior to application for Certificate of Substantial Performance of the Work, complete list of systems for which instructions were given, stating for each system:
 - .1 date instructions were given to Owner's staff;
 - .2 duration of instruction;
 - .3 names of persons instructed;
 - .4 other parties present (manufacturer's representative, consultants, etc.).
- .7 Obtain signatures of Owner's staff to verify they properly understood system installation, operation and maintenance requirements, and have received operating and maintenance instruction manuals and "as-built" record drawings.
- .8 Submit to Consultant copy of electronic version of training materials loaded on USB flash drive. Include in operating and maintenance manuals submission.
- .9 Provide universal serial bus (USB) recording of operating and instructions training for following systems:
 - .1 emergency power gensets and control system;
 - .2 fire alarm system;
 - .3 security systems;
 - .4 lighting control system;
- .10 Provide custom video in USB format that details on site systems and equipment operations and includes following:
 - .1 professional videographer on site to capture training session; use wireless lavalier microphone to capture crystal clear audio of trainer in association with video footage; edit video to remove unnecessary footage;
 - .2 USB to include custom site specific system/equipment screens that outline key information about system/equipment and devices used on site only;
 - .3 USB to also include custom site specific video that details programming procedures in conjunction with a voiceover from on-site technician;
 - .4 USB created with a main menu screen and authored with chapters to allow operator to access specific areas of training instantly.
- .11 Supply minimum quantity of 3 copies of DVDs for each system/equipment. Owner to have option of such information loaded and submitted on USB flash drives.

1.32 **FINAL INSPECTION**

- .1 Submit to Consultant, written request for final inspection of systems. Include written certification that:
 - .1 deficiencies noted during job inspections have been completed;
 - .2 field quality control procedures have been completed;
 - .3 maintenance and operating data have been completed and submitted to, reviewed and accepted by Consultant;

- .4 tags and nameplates are in place and equipment identifications have been completed;
- .5 clean-up is complete;
- .6 spare parts and replacement parts specified have been provided and acknowledged by Consultant;
- .7 as-built and record drawings have been completed and submitted to, reviewed and accepted by Consultant;
- .8 Owner's staff has been instructed in operation and maintenance of systems;
- .9 commissioning procedures have been completed.

1.33 SUBMITTALS

- .1 Submit shop drawings for products of this Section.
- .2 Additionally as part of shop drawing submission process, submit following to Consultant for review:
 - .1 sample of each proposed type of access door if supplied under work of this Division, as well as electronic copies of reflected ceiling plan drawings and wall elevation drawings showing proposed access door locations;
 - .2 dimensioned location drawings indicating required sleeves and formed openings in structural poured concrete or precast concrete construction or in roofing, and locations of cutting or drilling required for Electrical Divisions work;
 - .3 samples of materials and any other items as specified in succeeding Sections of Electrical Divisions;
 - .4 weight loads of selected equipment (upon request);
 - .5 equipment nameplate and warning sign proposed nomenclature, print type, symbols, sizing and colours;
 - .6 fire stopping installation drawings with ULC certifications;
 - .7 copies of prior to start of construction approvals from local governing authorities having jurisdiction.
- .3 Prior to application for Substantial Performance of the Work, submit following to Consultant for review (note: funds will be withheld until each of following items have been completed and documented to satisfaction of Consultant):
 - .1 fire alarm system testing and verification report of each component of work; devices to be certified working and in proper order;
 - .2 final distribution system testing and arc flash study performed and documented to satisfaction of Consultant;
 - .3 structured network cabling system tested and verified to be operating and performing in accordance with specified standards.

1.34 CONTINUITY OF SUPPLY FOR STANDARDIZATION

- .1 Utilize materials of one manufacturer for aspects of work, where practical. Utilize one common manufacturer for wiring devices, such as switches and receptacles, whether installed loose or in a pre-manufactured component. Coordinate with each supplier and ensure conformance with this requirement. Identify deviations to Consultant and obtain approval of change prior to proceeding with work.

1.35 **PRODUCT REQUIREMENTS IN SPECIAL AREAS**

- .1 Products in non-climate controlled areas are to include weatherproof provisions such as gasketed covers, corrosion resistant hardware, weatherproof finishes, etc. Devices to be manufactured to operate in extreme temperatures.
- .2 Products in public areas such as exterior areas and in parking areas are to also be vandal-proof and impact resistant.

1.36 **ADDITIONAL WORK ITEMS**

- .1 Following description of work includes labour, material, payroll burden, small tools, overhead, profit, and specific tax. Amounts for Work are to include applicable programming, testing, and verification. Harmonized Sales Tax (HST) is not included in amount, but is to be identified separately. Work described below is included in Bid Price:
 - .1 provision of 3 recessed ceiling fire alarm speakers, each with 15 m (50') of conduit and wire;
 - .2 provision of 5 exit lights, each with 15 m (50') of conduit and wire;
 - .3 provision of 10-20A duplex receptacles and circuits, each with outlet box, 15 m (50') of conduit and power wire to receptacle panel;

2 Products

2.1 **CONDUITS**

- .1 EMT (Thinwall), galvanized electrical metallic tubing to CSA C22.2 No. 83, complete with factory made bends where site bending is not possible and joints and terminations made with steel couplers and steel set screw type connectors with insulated throats, and concrete tight where required.
- .2 Galvanized steel flexible liquid tight metallic conduit to CSA C22.2 No. 56, complete with Ideal "Steel Tough" liquid-tight flexible conduit connectors at terminations.
- .3 Galvanized steel flexible metallic conduit to CSA C22.2 No. 56, complete with proper and suitable squeeze type connectors at terminations.
- .4 CSA approved and labelled, FT-4 rated, rigid plastic (PVC) conduit complete with site made heat gun bends on conduit to 50 mm (2") diameter, factory made elbows in conduit larger than 50 mm (2") diameter, solvent weld joints, factory made expansion joints where required, and terminations made with proper and suitable connectors and adaptors.
- .5 Medium density CSA certified polyethylene flexible plastic conduit in a continuous coil of proper length.
- .6 ENT – electrical non-metallic tubing to CSA C22.2 No. 227.1 and No 85, complete with matching ENT fittings and boxes; concrete tight and constructed of heavy duty impact resistant PVC; tubing of flexible corrugated construction; acceptable manufacturer is IPEX "Cor-Line" tubing with "Kwikon" fittings.

2.2 **OUTLET BOXES**

- .1 CSA approved stamped galvanized steel outlet boxes.
- .2 Crouse-Hinds Canada Ltd., CSA certified, "FS" or "FD" Series cast Feraloy and aluminium
- .3 CSA certified rigid plastic (PVC) outlet boxes.

- .4 Standard general purpose service floor boxes: CSA approved, UL scrub water compliant, fully adjustable angular and vertically, formed steel/cast iron, round single gang / rectangular or square multi-gang as required, flush in concrete floor installation, boxes complete with conduit knockout openings, adjustable collars, hinged flip open brass covers with provisions for mounting of duplex power receptacles, telephone jacks and data jacks. Provide barriered boxes when boxes contain both power and communication outlets and different voltage levels. Size boxes to suit thickness of floor slab as confirmed with Consultant and also to suit required bending radii of conductors. Refer to drawings for number of gang requirements. Acceptable manufacturers are Hubbell, Legrand and Thomas & Betts. Special floor boxes are specified elsewhere in another Section.
- .5 Each outlet box and back box to be suitable in respects for application and complete with suitable securing lugs, connectors suitable for connected conduit, knockouts and, where necessary, suitable plaster rings, concrete rings, covers, carpet flanges and any other required accessory.
- .6 Electrical boxes exposed exterior of building or in non-climate controlled locations to be weatherproof boxes complete with gasketed covers/faceplates.

2.3 **PULLBOXES AND JUNCTION BOXES**

- .1 Galvanized or prime coat plated steel, suitable in respects for application and complete with screw-on or hinged covers as required, and connectors suitable for connected conduit.
- .2 Cooper Crouse-Hinds, "Condulet", threaded cast Feraloy outlet boxes of an exact type to suit application, each complete with screw-on gasketed cover.
- .3 Rigid plastic (PVC), CSA certified, junction boxes and access fittings with solvent weld type joints and screw-on PVC covers.
- .4 Physical size of pullboxes to be as required by local governing electrical code to suit number and size of conduits and conductors.
- .5 Each box to be suitable in respects for application and complete with suitable securing lugs, connectors suitable for connected conduit, knockouts and, where necessary, suitable plaster rings, concrete rings, covers and any other required accessory.
- .6 Boxes exposed exterior of building or in non-climate controlled locations to be weatherproof boxes complete with gasketed covers.

2.4 **SLEEVES**

- .1 Galvanized steel sleeves as follows:
 - .1 No. 24 gauge with an integral flange at one (1) end to secure sleeve to formwork construction;
 - .2 Schedule 40 pipe;
- .2 Schedule 40 PVC sleeves.

2.5 **FIRESTOPPING AND SMOKE SEAL MATERIALS**

- .1 Asbestos-free, elastomeric materials and intumescent materials, tested, listed and labelled by ULC in accordance with CAN 4-S115-M85, and CAN/ULC-S101-M for installation in ULC designated firestopping, and smoke seal systems to provide a positive fire, water and smoke seal and a fire resistance rating (flame, hose stream and temperature) no less than fire rating for surrounding construction.

- .2 Fire stopping and smoke seal material system to be specifically ULC certified with designated reference number for its specific installation. As part of shop drawing submission, submit copies of firestopping drawings with ULC certificate and number for each specific installation. Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
- .3 Systems to consist of both elastomeric and intumescent materials that are compatible with abutting dissimilar materials and finishes. Coordinate material requirements with trades supplying abutting areas of materials.
- .4 Typically, for openings of up to 250 mm (10") in diameter, provide putty pad type firestop materials equivalent to Specified Technologies Inc. "SpecSeal" intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibres or silicone compounds.
- .5 Typically, for openings of greater than 250 mm (10") in diameter, and for rectangular openings, provide pillow type firestop materials equivalent to Specified Technologies Inc. "SpecSeal" re-enterable, non-curing, mineral fibre core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag.
- .6 Supply products of a single manufacturer for use on work of this Division.
- .7 Installer to be manufacturer trained and certified on specific product. Submit copy of certificate with shop drawings.
- .8 Include for manufacturer's authorized representative to inspect and verify each installation and application. Submit test report signed and verified by system installer's authorized representative and manufacturer's representative.
- .9 Acceptable certification to also include certification by Underwriters Laboratories of Northbrook IL, using tests conforming to ULC-S115 and given cUL listing published by UL in their "Products Certified for Canada (cUL) Directory".
- .10 Acceptable manufacturers are:
 - .1 Specified Technologies Inc.;
 - .2 3M Canada Inc.;
 - .3 Tremco;
 - .4 A/D Fire Protection Systems;
 - .5 Nelson;
 - .6 Hilti Canada.

2.6 **FASTENING AND SECURING HARDWARE**

- .1 Concrete inserts - Crane Canada Ltd., No. 4-M for concrete work for single or double conduit, cable tray, etc., runs and equipment. Unistrut Ltd. multiple type inserts for runs of three (3) or more conduits etc., or where a grid support system is required.
- .2 Concrete fasteners – "WEJ-IT" anchors, lead cinch anchors and/or "STAR" or "PHILLIPS" self-drilling anchors.
- .3 Masonry inserts – "WEJ-IT" expansion shields and machine bolts or, for light loads, fibre or lead plugs and screws.
- .4 Drywall or plaster wall and/or ceiling fasteners – 2-wing spring toggles.
- .5 Structural steel - Crane Canada Ltd., beam clamps.

- .6 Metal framing channels – 40 mm (1-5/8") width, galvanized steel channels complete with required fittings and ancillary hardware; acceptable manufacturers are:
 - .1 Unistrut;
 - .2 Thomas & Betts;
 - .3 Eaton B-Line.
- .7 Metal "J" hooks or Panduit "J-Pro" cable support systems for communications system cabling in accessible ceiling spaces where conduit or cable tray is not being provided. Obtain written approval of Consultant for use of J-hooks.
- .8 Velcro tie wraps for bundling and securing cables.

2.7 ACCESS DOORS

- .1 Access doors to be provided under work of Division 08 by General Trades Contractor.
- .2 Coordinate with Mechanical Contractor and General Trades Contractor to ensure that access doors on project are provided by a single manufacturer, installed as part of work of General Trades Contractor and that work involving both mechanical and electrical services to where possible be accessible from common access door. Coordinate work to ensure that same common location access doors are not supplied by more than one Division.
- .3 Size access door to suit concealed work for which they are supplied and wherever possible they are to be of standard size for all applications, but in any case they are to be minimum 300 mm x 300 mm (12" x 12") for hand entry and 600 mm x 600 mm (24" x 24") for body entry.
- .4 Access doors in fire rated ceilings, walls, partitions, structures, etc., to be ULC listed and labelled and of a rating to maintain fire separation integrity.
- .5 Identify on reflected ceiling plans and wall elevation drawings, coordinated locations of proposed access door locations and submit to Consultant for review.

2.8 IDENTIFICATION NAMEPLATES

- .1 Laminated plastic (Lamacoid) black-white-black with bevelled edges, stainless steel screws, and proper identification engraving. Each nameplate to be sized to suit equipment for which it is provided, and required wording. Confirm nomenclature with Consultant. Various colour configurations to be used to differentiate systems. Confirm exact colour scheme with Consultant and/or Owner.
- .2 Brother "P-Touch", portable electronic labelling system complete with self-adhesive, permanent printed labels with required nomenclature.

2.9 WARNING SIGNS

- .1 Thomas & Betts Ltd., semi-rigid vinyl panels with drilled holes in each corner, stainless steel screws, pressure sensitive mounting pads on back, and required printed wording. Generally, wording to be red on a white background with black trim confirmed with Consultant.

2.10 SYSTEM BACKBOARDS

- .1 FSC (Forest Stewardship Council), G1S (good one side) construction grade fir plywood, containing no added urea formaldehyde, flame retardant prime coat painted on exposed surfaces, minimum 20 mm (3/4") thick, as sized on drawings and with flame spread rating in accordance with local governing building code requirements.

2.11 **MOTOR STARTER PANELS**

- .1 Minimum No. 14 gauge sheet steel panels complete with steel angle reinforcing, framing and suitable splitter trough, fully primed and enamel painted, sized to accommodate starters required with spare space and capacity for at least two additional units.

2.12 **SPRINKLER PROTECTION**

- .1 Provide drip shields for protection of surface mounted equipment enclosures from water spray and dripping of liquids. Features of shields include:
 - .1 factory constructed by respective equipment manufacturers;
 - .2 constructed from non-combustible materials (sheet steel);
 - .3 enamel painted to match equipment;
 - .4 surfaces and edges filled/sanded smooth prior to painting;
 - .5 supported from equipment with structural steel rods/metal framing or other method approved by Consultant;
 - .6 structural support finish painted to match shield.
- .2 Include with equipment shop drawings, detailed dimensions of drip shields and methods of supporting.
- .3 Equipment with top cable/conduit entries to include additional sealing of entries with gasketting and/or waterproof sealant to prevent water from entering enclosure.
- .4 Design ventilation louvers such that live components are not exposed to water spray and dripping liquids.
- .5 Above requirements are additional minimum "sprinkler protection" standards for equipment specified as EEMAC/NEMA 1, 2 or 12.
- .6 Obtain CSA approval where required by local governing authorities.

3 Execution

1.1 **DISCONNECTION, REMOVAL AND RELOCATION WORK**

- .1 Where indicated on drawings or where required to perform Work of this Project, disconnect and remove items of existing obsolete electrical work. Relocate required devices as required to accommodate work of other Divisions. Where luminaires, switches, receptacles, and other devices and/or equipment is removed, disconnect at point of electrical supply, remove obsolete wiring and conduit up to source, unless otherwise noted, and make system safe to Owner's satisfaction and as reviewed with Consultant. Remove obsolete conduit/raceways in accessible ceiling spaces, exposed locations, etc. Where existing obsolete conduit and similar raceway material cannot be removed, such as embedded in concrete, cut back and cap obsolete conduit and raceways. Refer to specific notes on drawings.
- .2 When respective work is deleted, such deletions are to in no way affect operation of any existing interconnected mechanical or electrical components that remain. When existing circuits are being disconnected, maintain supervision of area to ensure that such circuits do not affect essential existing circuits being retained.
- .3 Refer to architectural drawings which define extent of areas being demolished in existing building. Review drawings and site and include for demolition and/or renovation of services as required to accommodate alterations detailed.

- .4 Unless otherwise noted, obsolete materials which are removed and are not to be relocated or reused are to become your property. Remove from site and properly dispose. Obtain from Owner and coordinate with Consultant, a list of existing electrical items which are to be removed and turned over to Owner. Said items are to remain property of Owner.
- .5 Where existing services pass through or are in an area to serve items which are to remain, or pass through areas that are to be deleted, maintain services, but re-route as required. Include for rerouting existing services concealed behind existing finishes and which become exposed during renovation work, so as to be concealed behind new or existing finishes. Confirm with Owner services which are to be kept in service and operational.
- .6 Revise panelboard directories accordingly, if affected by any renovation, disconnection, or removal of work. Use Owner's actual room names/numbers.
- .7 Protect existing devices being relocated or deleted to ensure that they are not damaged. Test such devices prior to disconnection and de-energization, to ensure that each device is in proper working condition. Ensure that motors are in proper rotation direction. Examine each device for damage. Report devices not working or with damage to Consultant prior to initiating any work. It will be assumed that devices are in proper working order and good condition if not reported.
- .8 Provide junction boxes, outlet boxes, wiring, plates, etc., as necessary for complete relocation of devices. Clean relocated or temporary removed devices and equipment, and ensure that they are in good operating condition before being reinstalled. Where existing luminaires are relocated, clean luminaires and inspect for damage. Relamp relocated luminaires. Report defects or damages to Consultant. Do not splice conductors unless approved by Owner and reviewed with Consultant. Utilize junction boxes and terminal devices for proper extension of circuits where approved. Otherwise replace circuits with home run continuous run of suitable lengths.
- .9 Provide blank coverplates on existing obsolete boxes which are to remain in position.
- .10 After installation is complete, test parts of re-used or relocated electrical equipment and correct faults and grounds. Include for fire alarm verification company to verify any relocated devices and downstream affected devices, and verify system as required by local fire authority to suit actual relocation work. For other existing systems, engage manufacturers authorized representative or Owner's system maintenance contractor, to inspect and verify relocated devices. Coordinate and confirm exact requirements with Owner and/or Consultant. Document testing in test reports, signed by testing technician. Submit copies to Consultant.
- .11 Interior, exterior or underground electrical services (including auxiliary services, telephone, fire alarm, P.A. System, etc.) to operating parts of building are not to be hampered under any conditions and to that effect, necessary work may have to be carried out on an overtime basis, at no additional cost to this project. Existing risers are to be maintained in service as required to feed other areas of building(s). Do not interrupt any services without prior written approval by Owner and reviewed with Consultant. Submit formal requests to Consultant outlining in detail requirements of proposal and wait for instructions from Consultant.
- .12 Be present when new doors or openings are being cut into existing walls and ceilings. Should any damage occur to electrical system, restore system to a safe and sound condition.

- .13 Where references are made on drawings that existing receptacles, etc., be extended and/or relocated to suit new construction, receptacles, etc., are to be tested and if found defective, be replaced with new devices. Cracked or broken cover plates are to be replaced and match Architectural finishes. Contractor may optionally replace existing basic receptacles, switches, and faceplates with devices matching existing devices.
- .14 Be responsible for disconnecting power supply to branch circuits controlling lighting, receptacles, panels, mechanical equipment, etc., for safe removal of equipment, conduit, wiring, boxes, etc., affected by demolition.
- .15 Close openings in boxes, panels, etc., that result from removal of equipment, conduit, wiring, fixtures, etc. Close openings in a proper manner and properly terminate and insulate cables to restore system to a safe operating condition, to Consultant's satisfaction.
- .16 Be present and supervise removal of electrical equipment, P.A. speakers, etc., during demolition of ceilings, walls, floors, etc. Existing equipment which is not to be relocated but interferes with demolition, are to be temporarily relocated until demolition work is completed. Services to temporarily relocated equipment are to be maintained at all times.
- .17 Remove and re-install existing ceiling tiles as required to perform work. Prior to removal, inspect tiles for damage and report any to Owner and Consultant. Any loose cabling is to be secured, and luminaires additionally supported with cables secured to ceiling slab. After work has been completed and successfully inspected, re-install ceiling tiles to existing standards and re-install devices. Be responsible for replacement of tiles and grid members damaged during work of Electrical Division. Comply with applicable governing authority requirements with regards to ceiling work in special areas.
- .18 Where existing surfaces are damaged by Electrical Divisions work and/or where existing devices are removed from wall, ceilings, floors and other surfaces, and such deleted devices are not being replaced in same locations, patch locations of these removed devices and re-finish. Patching and finishing is to be provided by tradesmen skilled in particular trade or application worked on, to Consultant's approval. Where openings are left in existing ceiling tiles, replace ceiling tiles with new matching tiles approved by Consultant. Unless otherwise included for in other Divisions, include for:
 - .1 preparing existing surfaces to be filled and repainted to be cleaned as required to remove dirt, dust, oil, grease, loose paint, rust and any other foreign matter which would prevent proper bonding of new finish; sand glossy surfaces to uniform dull texture;
 - .2 filling in and patching surfaces with same material as existing surfaces; finished surfaces to match and line with existing adjoining surfaces;
 - .3 providing fire stopping materials to maintain fire rating of the existing surfaces; refer to specification article entitled - Firestopping and Smoke Seal Materials.
 - .4 using paint rollers and/or brushes to apply and extend paint finish over full height and/or width of area affected, to a straight line in location determined by Consultant;
 - .5 applying sufficient number of coats such that patched area is indistinguishable to surrounding area;
 - .6 materials used to be of equivalent quality to existing finishes standards and be compatible with finishes to which they are applied;
 - .7 finishes to be approved by Owner and reviewed with Consultant.

- .19 Check luminaires to be deleted for PCB ballasts. Disconnect and remove such ballasts. As specified previously, include for company specialized in such hazardous materials to remove and dispose such materials off-site in compliance with Ministry of Environment, Ministry of Transport and any other governing authority regulations.
- .20 If at any time during course of building work, asbestos containing materials are encountered or suspected, cease work in area in question and immediately notify Consultant. Comply with local governing authority regulations. Do not resume work in affected area without approval from Consultant.

3.2 GENERAL CONDUIT INSTALLATION REQUIREMENTS

- .1 Install conduit concealed in finished areas, and concealed to degree made possible by finishes in partially finished and unfinished areas. Conduit may be exposed in unfinished areas such as Electrical and Mechanical Rooms, unless otherwise noted on drawings or specified herein. Refer to and examine architectural drawings and room finish schedules to determine finished, partially finished or unfinished areas of building. Documents do not identify exact routing. Where shown, routing is diagrammatic, identifying general requirements of routing and locations. Include for necessary offsets, fittings, transformations and similar items required as a result of obstructions and other architectural or structural details not shown.
- .2 Where conduits are exposed, arrange them to avoid interference with other work, parallel to building lines and install as high as possible. Do not install conduits within 150 mm (6") of "hot" pipes or equipment unless conduits are associated with equipment. Independently run conduit to be supported from wall/ceiling structure, not from ceiling hangers, ductwork, piping, cable trays, formed steel decking, etc. Do not run conduits within 900 mm (3') of equipment access opening covers.
- .3 Where conduit is proposed to be embedded within structural concrete, obtain Owner's approval and review with Consultant (Structural Engineer). Install such conduit in compliance with requirements of latest edition of CSA Standard CAN3-A23.1, "Concrete Materials, and Methods of Concrete Construction". Confirm and review with Structural Consultant, proper installation practices and methods. In areas where Consultant has directed conduit not to be embedded in concrete, run conduits through beams via sleeved openings pre-coordinated and reviewed with General Contractor and by Consultant (Structural Engineer). Do not embed conduit runs in concrete slab of parking garage areas, unless approved by Owner and reviewed with Consultant.
- .4 So as not to impair required strength of structure, following criteria to be generally followed but which is to be reviewed and coordinated with with Consultant prior to start of Work:
 - .1 where conduits pass by a column, stay at least two times thickness of slab and drop away from column;
 - .2 where conduits terminate adjacent to a column or wall, bring conduit in toward column/wall as close to 90° to face of column as possible within two times thickness of slab and drop away from column;
 - .3 maximum size of conduit in structural slabs is 1/5 of solid portion of slab thickness;
 - .4 where more than two conduits are adjacent to each other, they are to be spaced greater of 3 diameters or 100 mm (4") apart;
 - .5 total of depth of conduits crossing over each other is to be less than one-third thickness of slab;

- .6 place conduit in middle third of thickness of slab; do not lay conduit directly on reinforcing steel;
- .7 do not run conduit adjacent to parallel reinforcing bars;
- .8 do not run conduit longitudinally in beam without approval of Owner and review with Consultant; pass through beams at right angles to span of beam;
- .9 where conduits pass through beams, maintain at least twice depth of beam separation away from supports;
- .10 do not run conduits in slab beside a drop or beam within twice depth of slab from edge of drop or beam;
- .11 do not run conduits through shear walls or columns without approval of Owner and review with Consultant;
- .12 do not place conduit in structural elements in parking garage structures, water retaining structures or structures subjected to de-icing chemicals, without approval of Owner and review with Consultant.
- .5 For proposed use of conduit runs underground below slab include following provisions:
 - .1 concrete encased ductbank with conduits of non-ferrous materials and sloped to drain properly into pit;
 - .2 proper drain pit;
 - .3 system to be a pull-in system;
 - .4 20% spare conduits (with minimum of at least 1);
 - .5 system proposal to consider and address any effects of magnetic fields.
- .6 Conduits are sized on drawings, but in absence of type and sizing, type and size to suit intended application in accordance with applicable local governing electrical code requirements. Sizes identified on drawings are minimum sizes and are not to be decreased unless approved by Owner and reviewed with Consultant.
- .7 Where chasing of floor slab to run conduit is not acceptable to Owner after review with Consultant, provide fire rated "poke-thru" assembly installed through floor and feed from conduit runs provided in ceiling space of floor below.

3.3 **INSTALLATION OF CONDUIT**

- .1 Provide conduit for conductors except armoured cable and copper sheathed mineral insulated conductors, and except where duct or similar raceway materials are provided.
- .2 Provide conduit as follows:
 - .1 for interior building surface mounted services greater than 600 V – rigid galvanized steel;
 - .2 for exposed conduit outside building, for semi-exterior areas such as loading areas and within parking garage floor areas – rigid galvanized steel (rigid PVC where permitted by local codes and Owner and reviewed with Consultant);
 - .3 for exposed conduit in non-climate controlled areas, in areas of corrosive elements – epoxy coated ridged galvanized steel;
 - .4 for branch circuit conductors underground inside building, and underground outside building beneath concrete, asphalt, and similar paving material-rigid PVC;

- .5 for branch circuit conductors underground outside building clear of concrete, asphalt and similar paving material-flexible polyethylene plastic conduit;
 - .6 for conductors in surface mounted conduit of parking garage – rigid galvanized steel; conduit not to be embedded in concrete within parking garage areas, unless approved in writing by Consultant; if approval obtained from Consultant, rigid PVC may be used embedded in concrete slabs;
 - .7 for exposed conduit mounted at a height of less than 1200 mm (4') in electrical, mechanical or other service areas – rigid galvanized steel;
 - .8 for short branch circuit connectors to motorized equipment and distribution transformers (minimum length 450 mm (18"), maximum length 600 mm (24") with 180° loop where possible) – galvanized steel flexible liquid-tight conduit;
 - .9 at points, where conductors cross building expansion joints – galvanized steel flexible conduit with no less than 600 mm (24") of extra curve;
 - .10 for branch circuit conductors in poured concrete slab – rigid PVC;
 - .11 for interior conduit above 50 mm (2") diameter containing distribution conductors or communication systems conductors (fire alarm, telephone etc.) (except as noted above) – EMT with separate insulated ground conductor;
 - .12 for conductors except as noted above or elsewhere in this Specification – EMT.
- .3 Run rigid conductors in rigid type conduits suitable for application. Do not use flexible conduit.
- .4 Secure conduit located in poured concrete work in place in a manner such that conduit will not float or move when concrete is poured. Adequately protect such conduit from damage prior to and during concrete pour, and from concrete and water penetration.
- .5 Review with Consultant prior to Start of Work, maximum allowable size of conduit for installation in poured concrete. Placement of reinforcing steel in structural concrete work will take precedence over placement of conduit. Spaced adequately multiple runs of conduit in poured concrete work, as reviewed with Consultant.
- .6 Install flexible polyethylene conduit in continuous lengths wherever possible and "snake" conduit in trench. Where joints are necessary, make same with nylon inserts and stainless steel gear type clamps. Terminate with rigid conduit threadless connectors. Grade bed to provide proper drainage of conduits.
- .7 Support underground conduit on a well-tamped flat bed of earth, free from rocks or protrusions of any kind. Grade and slope bed to provide conduits and ducts with proper drainage. Coordinate with General Trades Contractor for provision of means to carry away drainage water. Obtain required approvals of work from local governing electrical utility and review with Consultant prior to back filling and covering. Provide pull cord in each duct run.
- .8 Provide manufactured expansion joints in rigid PVC plastic conduit at spacing as recommended by conduit manufacturer.
- .9 Provide a separate ground conductor in plastic conduits.
- .10 Support and secure surface mounted and suspended single or double runs of metal conduit at support spacing in accordance with local governing electrical code requirements by means of galvanized pipe straps, conduit clips, ringbolt type hangers, or by other proper manufactured devices.

- .11 Support multiple mixed size metal conduit runs with Unistrut Ltd., Electrovert Ltd. "CANTRUSS" or Burndy Ltd. "FLEXIBLE" conduit racks spaced to suit spacing requirements of smallest conduit in group.
- .12 Unless otherwise noted, provide conduit fittings constructed of same materials as conduit and which are suitable in respects for application.
- .13 Provide proper adaptors for joining conduits of different materials.
- .14 Cut square and properly ream site cut conduit ends.
- .15 Use of ENT is subject to written consent of Owner and review by Consultant. Where use is approved by Owner and reviewed with Consultant, run ENT embedded in concrete floor slabs and install in accordance with local governing electrical code requirements and manufacturer's instructions. Secure runs to maintain them straight and parallel/perpendicular to building lines. Allow for Consultant to inspect installation before concrete pour.
- .16 Provide conduit as sized on drawings. Size conduit not sized on drawings in accordance with latest edition of local governing electrical code with consideration that sizes of branch circuit conductors indicated are minimum sizes and must be increased as required to suit length of run and voltage drop in accordance with voltage drop schedule found on drawings or at end of this section. Where conductor sizes are increased to suit voltage drop requirements, increase scheduled or specified conduit size to suit. Unless otherwise noted on drawings or required by local governing electrical code or specified elsewhere, conduit to be of minimum size 13 mm (1/2") diameter. Structured network cabling system conduit to be of minimum 19 mm (3/4") diameter, unless otherwise noted.
- .17 Site made bends for conduit to maintain full conduit diameter with no kinking, and conduit finishes are not flake or crack when conduit is bent.
- .18 Plug ends of roughed-in conduits which are exposed during construction with approved plugs.
- .19 Ensure that conduit systems which are left empty for future wiring are clean, clear, capped and properly identified at each termination point. Provide end bushing and suitable fish wires in such conduits.
- .20 Provide empty conduits to ceiling spaces from flush mounted panelboards located below and/or near hung ceiling. Refer to drawing detail.

3.4 **EXPANSION FACILITIES FOR CONDUIT CROSSING BUILDING EXPANSION JOINTS**

- .1 Wherever concealed or surface mounted conduits cross building expansion joints, provide expansion facilities to permit free movement without imposing additional stress or loading upon support system, and to prevent excessive movement at joints and connections, in accordance with drawing details.

3.5 **INSTALLATION OF OUTLET BOXES AND BACK BOXES**

- .1 Provide an outlet box or back box for each luminaire, wiring device, telephone outlet, fire alarm system component, communications systems components, and each other such outlet.
- .2 Size boxes to accommodate exact supplied components and for bending radii of installed cables. Confirm requirements with respective system vendors.

- .3 Outlet boxes flush mounted in interior construction, surface mounted in concealed interior locations, and surface mounted in exposed interior locations where connecting conduit is EMT, to be stamped and galvanized steel outlet boxes unless otherwise noted.
- .4 Outlet boxes for surface mounted exterior lighting, receptacles, and other device outlets, boxes flush mounted in exterior building surfaces, and boxes mounted in interior device locations where connecting conduit is rigid and boxes in perimeter wall where insulation and vapour barrier is present, and boxes in non-climate controlled areas to be "FS" or "FD" Series cast boxes unless otherwise noted.
- .5 Provide sealing around boxes in walls where insulation and vapour barrier is present or for walls of rooms that are sealed. Maintain sealing system of wall.
- .6 Outlet boxes in underground plastic conduit systems to be rigid PVC plastic outlet boxes, unless otherwise noted.
- .7 Outlet boxes for flush floor mounted devices to be concrete tight formed galvanized steel fully adjustable flush floor boxes. Locate in to position and install in accordance with manufacturer's instructions. Coordinate installation with trades pouring concrete floor slab or trade responsible for floor construction.
- .8 Provide a barriered outlet box for switches connected to normal and emergency power and share a common faceplate.
- .9 Provide outlet boxes for special wiring devices, for special equipment and special applications. Refer to requirements specified in other Sections and/or on drawings.
- .10 Size and arrangement of outlet boxes to suit device which they serve.
- .11 Mounting heights and locations for outlet boxes are typically indicated on drawings, however confirm exact location and arrangement of outlets prior to roughing-in. Architectural drawings and Consultant's instructions have precedence over electrical drawing diagrammatic layouts and specified mounting heights and locations.
- .12 Do not install outlet or back boxes "back-to-back" in walls and partitions. Stagger such outlets and seal against noise transmission in accordance with drawing details. "Thru-wall" type boxes will not be permitted for any application.
- .13 Provide blank coverplates over boxes left empty for future installation of devices. Clearly identify each box as to its intended use, to Owner's approval and reviewed with Consultant. Generally, provide stainless steel type blank coverplates.

3.6 **INSTALLATION OF PULLBOXES AND JUNCTION BOXES**

- .1 Provide pullboxes in conduit systems wherever shown on drawings, and/or wherever necessary to facilitate conductor installations. Generally, conduit runs exceeding 30 m (100") in length, or with more than two - 90° bends, are to be equipped with a pullbox installed at a convenient and suitable intermediate accessible location.
- .2 Size boxes to accommodate exact supplied system and for bending radii of installed cables. Confirm requirements with respective system vendors.
- .3 Provide junction boxes wherever required and/or indicated on drawings and as required by local governing electrical code.
- .4 Provide sealing around boxes in walls where insulation and vapour barrier is present or for walls of rooms that are sealed. Maintain sealing system of wall.
- .5 Boxes in rigid conduit and EMT inside building to be stamped galvanized or prime coated steel.

- .6 Boxes in exterior rigid conduit and boxes in perimeter wall where insulation and vapour barrier is present, to be "Condulet" cast gasketed boxes, unless otherwise noted.
- .7 Boxes in plastic conduit to be rigid PVC plastic boxes complete with required couplings.
- .8 Pullboxes and junction boxes to be accessible after work is completed.
- .9 Accurately locate and identify concealed pullboxes and junction boxes on "As-built" record drawings.
- .10 Clearly identify main pull or junction boxes (excluding obvious outlet boxes) by painting outside of covers. Spray painting is not permitted unless approved by Owner and reviewed with Consultant. Paint colours to be in accordance with following schedule:
 - .1 lighting-yellow;
 - .2 normal power-blue;
 - .3 essential power-orange;
 - .4 fire alarm-red;
 - .5 telephone-green;
 - .6 miscellaneous signals-brown.
- .11 In addition to painting miscellaneous signal boxes, clearly identify specific system in which box is installed.
- .12 Cover boxes in fire walls with aluminium tape and seal with caulking.

3.7 **INSTALLATION OF SLEEVES**

- .1 Where conduits, round ducts and conductors pass through structural poured concrete, provide sleeves of type suitable for application, and approved by local governing codes.
- .2 Sleeves in concrete slabs, except as noted below, are to be No. 24 gauge or equivalent, with an integral flange to secure sleeves for formwork construction.
- .3 Sleeves in waterproof concrete slabs and in other slabs where waterproof sleeves are required are to be lengths of Schedule 40 pipe sized to extend 100 mm (4") above floor.
- .4 Sleeves in poured concrete walls and foundation are to be Schedule 40 pipe.
- .5 Size sleeves, unless otherwise noted, to leave 13 mm (1/2") clearance around conduit, duct, conductor, etc. Void between sleeves and conduit, duct, conductors, etc., to be packed and sealed for length of sleeves as in accordance with article entitled "Firestopping and Smoke Seal Materials" specified here in this Section. Ensure that sleeves set in exterior walls are packed and sealed with governing authority approved materials suitable for application and that both ends of sleeves are packed watertight with approved permanently flexible and water tight materials. Exact responsibility of work to be coordinated with General Trades Contractor.
- .6 Submit to concrete reinforcement detailer at proper time, drawings indicating required sleeves, recesses and formed openings in poured concrete work. Completely and accurately dimension such drawings and relate sleeves, recesses and formed openings to suitable grid lines and elevation datum.
- .7 Supply sleeves of a water protecting type in accordance with detail found on drawings for installation in following locations:
 - .1 in Mechanical and Fan Room floor slabs, except where on grade;

- .2 in slabs over Mechanical, Fan, Electrical and Telephone Equipment Rooms or closets;
- .3 in floors equipped with waterproof membranes.
- .8 "Gang" type sleeving to be permitted only with approval of Owner and reviewed with Consultant.
- .9 Terminate sleeves for work which is exposed, so that sleeve is flush at both ends with wall, partition, or slab surface such that sleeve may be covered completely by escutcheon plates.

3.8 **INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS**

- .1 Where electrical work penetrates or punctures fire rated construction, provide ULC certified, listed and labelled firestopping and smoke sealing packing material systems to seal openings and voids around and within raceway and to ensure that continuity and integrity of fire separation is maintained. Submit to Consultant, copies of certificates of compliance from an independent testing agency, attesting that fire stopping and smoke seal materials meet ULC requirements. Openings not in immediate vicinity of working areas are to be firestopped and sealed same day as being opened.
- .2 Examine condition of voids to be filled to ensure suitability for systems. Verify installation of service penetrations and adjacent construction has been completed. Prepare substrates and surfaces to a clean, dry, frost-free condition, and primed to firestop system manufacturer's recommendations to receive firestopping system.
- .3 Install fire stopping and smoke seal materials for each installation in strict accordance with specific ULC certification number and manufacturer's instructions. Comply with local governing building code requirements and obtain approvals from local building inspection department. Ensure that openings through fire separations do not exceed maximum size wall opening, and maximum and minimum dimensions indicated in ULC Guide No. 40 U19 for Service Penetration Assemblies and fire stopping materials.
- .4 Ensure that continuity and integrity of fire separation is maintained and conform to requirements of latest edition of ULC publication "List of Equipment and Materials, Volume II, Building Construction".
- .5 After installation work is complete, arrange for manufacturer's authorized representative to inspect and verify each installation and provide a test report signed by installing trade and manufacturer's representative. Test report to list each installation and respective ULC certification and number.

3.9 **INSTALLATION OF FASTENING AND SECURING HARDWARE**

- .1 Provide fasteners and similar hardware required for conduit, duct, raceway, conductors, etc. and for equipment hanger and/or support material unless otherwise noted.
- .2 Accurately and properly set concrete inserts in concrete framework. Where multiple type inserts are used, space same to suit requirements of smallest conduit, etc., in group.
- .3 Fasten hanger and support provisions to masonry with expansion shields and machine bolts, or, for light loads, use plugs, and screws.
- .4 In drywall or plaster walls and/or ceilings use two wing toggles and for heavy loads, provide steel anchor plates with two or more toggles to spread load.
- .5 Provide beam clamps for attaching hanging and/or support provisions to structural steel, or where approved by Owner and reviewed with Consultant, weld hanging and support provisions to structural steel.

- .6 Explosive powder actuated fasteners are not permitted unless specific written approval for their use and type has been obtained from Consultant.
- .7 Under no circumstances use ceiling suspension hangers or grids for suspension of conduit and conductors. Install supports to permanent structure of building, limited to areas that will not damage structural stability.
- .8 Provide "J" hooks in accessible ceiling spaces where conduit is not provided for structured cabling runs or other telecommunication cabling, as approved by Consultant.
- .9 Comply with J-hook manufacturer's loading limitations and spacing criteria. Do not exceed 1.2 m (4') spacing interval. Add additional J-hooks if cabling sags, at discretion of Consultant. Drill anchors for J-hooks into slab not into post tensioned beams. Do not install more than one system on each J-hook.
- .10 Install Velcro tie wraps on bundled telecommunication cables and do not over tighten. Provide FT6/CMP rated wraps in plenum type spaces as per local building code requirements.
- .11 Comply with Structural Engineer's limitations for maximum penetrations of securing hardware into concrete slabs.

3.10 **INSTALLATION OF IDENTIFICATION NAMEPLATES**

- .1 For each piece of electrical distribution equipment from electrical source of supply up to and including panelboards, for special control panels and cabinets, and for each other piece of electrical equipment, provide engraved Lamacoid identification nameplates secured to apparatus with stainless steel screws. Nameplates to indicate source of electrical supply and include Consultant's equipment identification number.
- .2 Equip large multiple cell or component apparatus such as switchboards and distribution panels with main nameplates identifying equipment, voltage characteristics, capacity and source of supply, and with sub-nameplates clearly identifying each cell or component and its service.
- .3 Panelboard nameplates to identify panelboard number as designated on drawings, unless otherwise instructed. Nameplates for disconnect switches, control panels, and cabinets to outline their service and source of supply.
- .4 In areas where equipment having removable doors that can be commonly installed on different equipment, ensure that each door is identified to which piece of equipment it is associated with, such that nameplates are with correct equipment.
- .5 Nameplates to be mechanically secured lamacoid and be colour coded as follows:
 - .1 Normal Power Black with white letters;
 - .2 Emergency Power Red with white letters;
- .6 Above identification nameplate and nomenclature requirements are for typical requirements for pricing only.
- .7 In pull boxes, junction boxes and at terminations, identify feeders by use of plastic plates indicating system voltage and circuit designations. Plates to be 25 mm (1") in diameter and have letter stamped 9 mm (5/8") high. Colour coding to be:
 - .1 Phase A – red;
 - .2 Phase B – black;
 - .3 Phase C – blue;
 - .4 Neutral – white;

- .5 Ground - green.
- .8 Confirm print size type and size, colours, sizing and nomenclature of nameplates with Consultant prior to ordering. Submit sample board.
- 3.11 **INSTALLATION OF TERMINAL BACKBOARDS**
 - .1 Provide specified terminal backboards for communication systems and electrical distribution equipment.
 - .2 Securely wall mount each backboard with proper fasteners to suit wall construction.
 - .3 Unless otherwise noted, size backboards to sufficiently provide adequate terminal space for each system, plus 20% space for future additions.
- 3.12 **INSTALLATION OF WARNING SIGNS**
 - .1 Provide warning signs as applicable for following:
 - .1 on doors into main electrical rooms;
 - .2 for other applications as noted.
 - .2 Secure signs to equipment with stainless steel screws. Number of signs required and sign wording, symbols, and colours to be approved by Owner and reviewed with Consultant, and local electrical utility, where applicable.
- 3.13 **BRANCH CIRCUIT BALANCING**
 - .1 Connect branch lighting and power circuits to panelboards so as to balance actual loads (wattage) within 5%. If required, transpose branch circuits when work is complete to meet this requirement.
 - .2 At request of Consultant, perform necessary tests to show compliance with above requirement. Make such tests after building is occupied.
- 3.14 **EQUIPMENT BASES AND SUPPORTS**
 - .1 Provide equipment bases, supports and concrete housekeeping pads for mounting of floor standing equipment and luminaire pole bases.
 - .2 Secure floor mounted equipment in place on 100 mm (4") high concrete housekeeping pads, 100 mm (4") wider and longer than equipment base dimensions. Chamfer edges of bases. Include for seismic restrains as required by local governing building code.
 - .3 Supply dimensioned drawings, templates, and anchor bolts for proper setting of equipment on bases and pads. Be responsible for required levelling, alignment, and grouting of equipment.
 - .4 Submit to Consultant for review, dimensioned shop drawings of structurally designed concrete pads or bases for support of large, heavy equipment. Indicate on shop drawings total weight of pad or base, reinforcement, and equipment for which it is required.
 - .5 Unless otherwise noted, support equipment suspended above floor level with suitable welded or bolted prime coat painted structural steel angles or channels bracketed to wall or secured by hanger rods.
- 3.15 **CUTTING, PATCHING AND CORE DRILLING**
 - .1 Unless otherwise noted, General Trades Contractors are responsible for cutting, patching, and core drilling of existing building required for installation of Work.

- .2 Where added conduits and/or conductors penetrate existing construction, identify, and mark out locations for openings. Size openings to leave 13 mm (1/2") clearance around conduit and/or conductors. Coordinate work with General Trades Contractor.
- .3 Ensure that openings in fire rated construction are sealed as per requirements of article entitled "Firestopping And Smoke Seal Materials" specified herein this Section and as per Division 07, as applicable.
- .4 Fire stop and seal openings as specified, and patch as required before end of workday. No openings are to be left open overnight unless approved by Owner and coordinated with Consultant.

3.16 FINISH PAINTING OF ELECTRICAL WORK

- .1 Unless otherwise noted, finish painting of exposed Electrical Divisions work is to be performed as part of work of Division 09.
- .2 Provide identification painting for electrical distribution equipment in accordance with application requirements of Division 09. Confirm exact finish colours with Consultant. Equipment requiring special colour identification painting to include but not be limited to following:
 - .1 pull boxes and junction boxes;
 - .2 communication system conduit;
 - .3 genset exhaust piping.
- .3 Spray painting is not permitted unless approved in writing by Owner and reviewed by Consultant.

3.17 CONDUIT PROVISIONS FOR MISCELLANEOUS SYSTEMS

- .1 Provide following components to accommodate future installation of various miscellaneous systems by system installers who are to provide equipment and wiring:
 - .1 conduit - diameters as sized on drawings with non-metallic fish wires or pull cords and suitable bushings for conduit terminations, and as specified in Part 2; provide labelling at each end to clearly identify each conduit run with respect to system and path;
 - .2 outlet boxes - standard galvanized steel, each complete with a blank type faceplate, and as specified in Part 2;
 - .3 pull boxes, junction boxes, back boxes and sleeves - and as specified in Part 2.
- .2 Miscellaneous systems are typically as shown on drawings. Unless otherwise noted on drawings, provide dedicated conduit runs for each system. Coordinate sizes of boxes with respective system vendors to ensure proper sizing to accommodate components and that allows for wiring bending radii. Confirm conduit and box requirements also with system vendors.
- .3 Provide pullboxes in conduit runs longer than 30 m (100') or having more than two - 90 bends. Size pullboxes to be at least 8 times entering conduit in length. Pullbox sizes to comply with respective system standards.

- .4 Leave conduits free and clear of all obstructions and terminate as required. Equip terminations with bushing, and clearly identify each run. Provide fish wires in all empty conduits. Run telecommunications conduits to comply with separation from sources of electromagnetic radiation as per standard ANSI/TIA/EIA-569. Site bend telecommunications conduit elbows to comply with system conduit bending radii requirements.
- .5 Confirm exact requirements and locations of equipment with Consultant and respective system installers prior to roughing-in.
- .6 Refer to system riser diagrams on drawings.
- .7 Quantities for outlets to be as per floor plan drawings and not riser diagrams.

3.18 DOOR HARDWARE

- .1 Generally, Division 08 or another Division not under scope of electrical Contractor, is responsible for supply and installation of door alarm contacts, door holders, electric strikes, electromagnetic locks, door operator controls, power supplies, door controllers, central electromagnetic lock release controller and other door hardware. Coordinate and confirm with General Trades Contractor and respective equipment vendors (door hardware / security) exact responsibility of each Division of the Work.
- .2 Confirm product and wiring requirements, back box requirements and wiring installation requirements with door hardware trades and with equipment vendors. Provide required wiring in conduit from each device to respective controllers, between each device, and to central control panel and for power connection to such controls and devices. Provide line level voltage power feeds to equipment as required.
- .3 For controls and interconnections between devices, when such device terminations are responsibility of others, supply and run interconnecting wiring in conduit to devices and allow spare length of 1.8 m (6') coiled wiring at each end for final termination to devices by others.
- .4 For applications of electro- magnetically held closed doors, engage fire alarm system vendor to provide fire alarm type pull station with auxiliary contacts as required for interconnection of electro- magnetic door hardware and fire alarm system for release of doors. Provide required wiring in conduit and connections. Coordinate pull station requirements with fire alarm system vendor.
- .5 Exact type of door alarm contacts to be coordinated with door construction and finishes. Contacts to generally be recessed mounted and wiring be installed in concealed conduits. Confirm exact requirements with door hardware / security vendor and General Trades Contractor.
- .6 Where controls are located remotely from door locations, such as in closets, provide wiring in conduit and extend from local above door junction boxes and devices as required with homeruns back to closet location of equipment and leave slack wiring for terminations by others. Confirm exact requirements with door hardware / security vendor and General Trades Contractor.
- .7 Drawing details issued with electrical drawings are for pricing reference only and are based on assumptions. Obtain detailed design drawings from successful door hardware / security vendors and provide wiring in conduit to coordinate with and accommodate final systems designs. Coordinate with General Contractor.

END OF SECTION

1 General

1.1 SUBMITTALS

- .1 Submit shop drawings for products and accessories.
- .2 Submit samples of conductors, when requested by Consultant.

2 Products

2.1 GENERAL POWER CABLES

- .1 CSA approved, ULC labelled and certified. Unless otherwise noted, conductors to be copper and be suitable for applications as noted in governing local electrical code.
- .2 "RW90" CSA certified, single copper conductor to CSA C22.2 No. 38, 600/1000 volts, maximum 90°C (194°F) conductor temperature, -40°C (-40°F) minimum installation temperature, X-link polyethylene (XLPE) insulation, colour coded.
- .3 "T90 Nylon", CSA certified, single copper conductor to CSA C22.2 No. 75, 600 volts, maximum 90°C (194°F) dry conductor temperature, -10°C (-14°F) minimum installation temperature, PVC insulated, nylon covered.
- .4 "TWU" single copper conductor to CSA C22.2 No. 75, 600 volts, maximum 60°C (140°F) conductor temperature, -40°C (-40°F) minimum installation temperature, PVC insulated suitable for wet and buried installations, colour coded.
- .5 "RWU90" CSA certified, single copper conductor to CSA C22.2 No. 38, 1000 volts, maximum 90°C (194°F) conductor temperature, -40°C (-40°F) minimum installation temperature, extra thickness X-link polyethylene (XLPE) insulation suitable for wet and buried installations, colour coded.
- .6 "AC90" flexible armoured cable with "RW90" conductors and bare copper ground conductor and overall interlocked aluminium tape armour, to CSA C22.2 No. 51 (R2004).
- .7 "AC90 ISO-BX" flexible armoured cable with "RW90" conductors with low temperature Exelene insulation and two additional solid copper bonding conductors (one bare, one insulated) and overall interlocked aluminium tape armour, to CSA C22.2 No. 51(R2004).
- .8 "NMD90" two or three copper conductors, to CSA C22.2 No. 48, with 90°C rated XLPE (R90) insulation; bare bonding wire and overall jacket of moisture resistant and flame retardant PVC; FT1 rating and rated 300 volts.

2.2 CONNECTORS

- .1 Armoured cable connectors must be proper squeeze type connectors and plastic anti-short bushings at terminations.
- .2 Connectors for conductors connecting to devices as per local governing electrical requirements to be equal to IDI Electric (Canada) Ltd., "Ideal" No. 451, No. 452 and No. 453, "Wing-Nut", CSA certified, 600 volts, rated pressure type connectors.
- .3 For conductors sized 3/0 and greater, provide long barrel double crimp, 2 hole compression type lug connectors, unless otherwise noted.

2.3 FIRE RATED CABLES

- .1 Pentair - Pyrotenax, model "System 1850", CSA certified, ULC listed and labelled, FM Specifications tested, 600 V, type "MI", 2 hour fire rated, copper sheathed, copper conductor, highly compressed magnesium oxide mineral insulated power cable. Connectors for copper-sheathed mineral conductors to be cable manufacturer's proper connectors and accessories as recommended by manufacturer to suit specific applications.
- .2 Pentair - Pyrotenax, model "System 1850 Twisted Pair", CSA certified as FAS, FAS 90 and FAS 105 cable, ULC listed and labelled, 300 V, type "MI", 2 hour fire rated, copper sheathed, copper conductor, highly compressed magnesium oxide mineral insulated fire alarm and voice communication cable. Connectors for copper-sheathed mineral conductors to be cable manufacturer's proper connectors and accessories as recommended by manufacturer to suit specific applications.
- .3 Manufacturer's termination kits: Pyropak epoxy sealing compound kits and "Quick Term" connectors; connectors for MI conductors to be cable manufacturer's proper connectors and accessories as recommended by the manufacturer to suit specific applications.
- .4 Cable clips and straps as recommended by cable manufacturer to suit specific installation application. In applications of dissimilar materials, provide tape to insulate cabling and hardware.
- .5 Brass plates for cable openings in ferrous metal enclosures.
- .6 Include for required cable manufacturer's accessories and identification labelling.
- .7 Include for manufacturer's authorized technician to be present on site for initial coordination with installing personnel on review of proper installation of cabling runs and termination of cabling. After completion of Work, manufacturer's technician to review installation work and provide in writing that installation work has been performed to satisfaction of cable manufacturer.
- .8 Acceptable manufacturer of fire rated MI type cables is Pentair Thermal Management.

2.4 **STANDARD CONTROL AND COMMUNICATIONS CABLES**

- .1 ULC listed and labelled, CSA certified to C22.2 No. 127, No. 18 AWG "TEW" thermoplastic insulated, solid copper wire rated for 600 volts service, and 105°C (220°F) conductor temperature, complete with required number of copper conductors and colour coding.
- .2 Nexans, "Securex II", FAS 105, 300 volts, 105°C (220°F) conductor temperature rated fire alarm system flexible armoured cable with solid copper conductor, shielding, flame retardant PVC insulation and red colour outer overall jacket, ULC listed and labelled and CSA certified to C22.2 No. 208.

2.5 **CONDUCTOR PULLING LUBRICANT**

- .1 IDI Electric (Canada) Ltd., "Ideal Yellow 77" or "Wire Lube" as required.

2.6 **CORFLEX CABLES**

- .1 CSA type "RA90" (X LINK) conductors, Nexans Corflex II cable suitable for 600 volt service and consisting of cross linked polyethylene insulated single copper conductors, 90°C (194°F) rated, enclosed by a continuous extruded corrugated aluminum sheath with an overall PVC jacket.
- .2 Acceptable manufacturers are:
 - .1 Nexans;

- .2 Prysmian Cables (Pirelli);
- .3 General Cable;
- .4 Aetna Cables;
- .5 Kerite Company.

2.7 **TECK CABLES**

- .1 Nexans, "Firex II Teck" cables as follows:
 - .1 certified to CAN/CSA C22.2 No.131, Type TECK 90 Cable;
 - .2 rated for outdoor, weather resistant and wet locations applications;
 - .3 600/1000 V rated;
 - .4 Conductor: Bare, Soft drawn, Class B Compact or Compressed Stranded Copper conductors per ASTM;
 - .5 insulation: chemically cross linked thermosetting polyethylene (XLPE);
 - .6 bonding conductor (1/C Cable): Soft drawn bare copper;
 - .7 inner jacket: sunlight resistant PVC jacket tightly applied over assembly, to prevent slipping of core in a vertical position;
 - .8 armour: flexible interlocked aluminum armour, over inner jacket for mechanical protection;
 - .9 overall PVC jacket rated -40°C (-40°F).
 - .10 barrier tape over shield.
- .2 Acceptable manufacturers are:
 - .1 Nexans;
 - .2 Prysmian Cables (Pirelli);
 - .3 General Cable;
 - .4 Aetna Cables;
 - .5 Kerite Company.

3 Execution

3.1 **PROJECT CONDITIONS**

- .1 If identified in documents, verify that field measurements and conditions are as identified.
- .2 Cable routing on drawings is schematic and approximate. Route cable as required to meet project conditions. Determine exact routing and lengths on site.
- .3 Confirm fire protection ratings of construction to ensure that rooms and paths of conductors are fire rated in accordance with local governing codes requirements. Include fire rated conductors as required to meet local governing codes requirements.

3.2 **CO-ORDINATION**

- .1 Co-ordinate work with work provided under other electrical work and work of other trades.
- .2 Determine required separation between cable and other work.

- .3 Determine cable routing to avoid interference with other work.
- .4 Submit any alternative cable routing to Consultant for review prior to proceeding with work.

3.3 **INSTALLATION OF CONDUCTORS**

- .1 Provide required conductors. Ensure fire rated conductors are provided for applications as required by local governing codes, standards and local governing authorities.
- .2 In applications where multiple conductors in conduit are being run, provide a trapeze configuration of metal C-channels and threaded rod hangers to support cable/conduit from ceiling slab. Wall mounted cable/conduit brackets and ring type conduit hangers may also be permitted in applications approved by Consultant. Provide required cable support system accessories which are not specified herein or shown on drawings but are required for proper installation.
- .3 Conductors, unless otherwise noted, to be as follows:
 - .1 residential feeders – "NMD90";
 - .2 underground inside or outside building and for non-climate controlled areas - "TWU" or "RWU90";
 - .3 for connections to electric heating coils in supply air ductwork systems, and for connections to other electric heating equipment where use of 90 degrees C. rated conductors are recommended by heating equipment manufacturer - "RW90";
 - .4 for conductors requiring fire rating by current regulations and local codes including feeders for emergency systems, fire fighter's elevators, fire alarm systems, other life safety systems and for applicable signal and control circuits of these systems - type "MI" CSA approved, ULC listed and labelled, 2 hour fire rated, copper sheathed mineral insulated copper conductors;
 - .5 climate controlled areas branch circuit wiring in accessible ceiling spaces and within stud wall construction consisting of drops down to luminaries and drops down stud walls to devices and in furniture systems - "AC90" flexible armoured cable ("BX") (maximum 6m (20') run permitted);
 - .6 for climate controlled areas wiring except as noted above or specified elsewhere in Specification or as noted on drawings - "T90 Nylon" or "RW90".
- .4 Support flexible armoured cable in ceiling spaces and in stud wall construction with steel 2 hole cable straps to "Code" requirements. Flexible armoured cables must run in a neat manner parallel to building lines. Utilize centralized conduit runs to maintain maximum permitted runs of flexible armoured cables as specified. Provide insulating grommet at cut ends of flexible armoured cable to protect conductor insulation.
- .5 Low voltage conductors to typically be No. 18 AWG "TEW" except for use in fire alarm system applications, unless otherwise noted. Provide specified fire alarm cables for fire alarm system applications or security system applications as approved by Code and local governing authorities. Conductors not installed in conduit or raceways to be fire insulated rated in accordance with latest governing Code Flame Spread requirements.
- .6 When installing type NMD90 conductors through metal studs, provide insulating grommets on stud openings to protect conductor insulation.

- .7 Generally, conductor sizes are indicated on drawings. Such sizes are minimum requirements and must be increased, where required, to suit length of run and voltage drop in accordance with applicable conductor voltage drop schedule appended to end of this Section.
- .8 Do not use conductors smaller than No. 12 AWG in systems over 30 volts, unless otherwise noted. Do not use conductors smaller than No. 6 AWG for exterior luminaire wiring unless otherwise noted.
- .9 Colour code conductors throughout to identify phases, neutrals and ground by means of self-laminating coloured tape, coloured conductor insulation, or properly secured coloured plastic discs. Colours, unless otherwise noted, to be as follows:
 - .1 Phase A - red;
 - .2 Phase B - black;
 - .3 Phase C - blue;
 - .4 Ground - green;
 - .5 Neutral - white;
 - .6 Control - orange.
- .10 When pulling wires into conduit use lubricant and ensure that wires are kept straight and are not twisted or abraded.
- .11 Control conductors, in addition, to be numbered with Brady Ltd. or Electrovert Ltd. Z type markers.
- .12 Colour code conductors for communications systems in accordance with system component manufacturer's recommendations.
- .13 Neatly secure exposed wire in apparatus enclosures with approved supports or ties.
- .14 Install low voltage conductors in conduits, unless otherwise noted within Documents.

3.4 **INSTALLATION OF FIRE RATED CONDUCTORS**

- .1 Submit with shop drawings, copy of manufacturer's detailed installation manual and testing procedures. Provide minimum 2 hour fire rated type "MI" CSA approved, ULC listed and labelled, mineral insulated copper conductors for following:
 - .1 emergency feeders from generators to transfer switches;
 - .2 feeders to elevators;
 - .3 feeders to fire pumps and sprinkler pumps;
 - .4 feeders to smoke venting fans;
 - .5 feeders to emergency panel boards;
 - .6 feeders to fire alarm control panels and transponders;
 - .7 fire alarm risers;
 - .8 feeders as required by Code requirements;
 - .9 applicable local governing code required applications for control and signalling conductor circuits of and between life safety equipment and systems;
 - .10 feeders and conductors as noted on drawings.

- .2 Provide fire rated type "MI" conductors for specific feeders as required and as noted. Install type "MI" copper sheathed, mineral insulated conductors for applications noted above and as shown on drawings in strict accordance with the manufacturer's instructions and recommendations. Refer to latest issue of Pyrotenax MI cable Commercial Wiring Installation Manual. Installation must be in a neat and professional manner as per manufacturer's approval. Make arrangements for manufacturer's technician to provide onsite services as specified.
- .3 Provide Unistrut C-channels, clips, wall brackets, etc., as required and as recommended by cable manufacturer to suit the on-site installation conditions. Provide system of Unistrut hangers and rods spaced at minimum 1.2 m (4') but which must be confirmed with cable manufacturer, for running of cables. Where clips and other hardware are in contact with cables, insulate cables/hardware with suitable tape as per cable manufacturer's recommendations for applications of dissimilar metals.
- .4 Make terminations of "MI" conductors with manufacturer's approved components and "Pyropak" or "Quick Term" connectors in accordance with the manufacturer's recommendations. Obtain proper tools for cable terminals from the cable manufacturer. Terminations must be completed immediately once started to avoid moisture ingress from the surrounding air. Connections to ferrous cabinets for single conductor cables shall incorporate brass plates sized as required and as per cable manufacturer's requirements. Brass plates shall be complete with required drilled and tapped holes. For 99°C applications, cable lugs shall be temperature rated as such.
- .5 When pulling cable, apply pulling tension to the conductor not in the sheath of the cable. Limit cable pulling tension to as recommended by cable manufacturer.
- .6 Terminate cable in the equipment with termination kits as per cable manufacturer's instructions.
- .7 Installation of cable terminations to be witnessed by manufacturer's authorized technician. Perform terminations in accordance with cable manufacturer's instructions.
- .8 Ground cabling as per cable manufacturer's instructions and as per local governing electrical code requirements.
- .9 Take necessary precautions when handling cable on reel to ensure that no damage will result in the uncoiling process.
- .10 Where cables penetrate fire rated construction, provide ULC listed and labelled, fire stopping and smoke seal materials or fittings to protect integrity of fire rated construction. Install work in compliance with ULC standards and where required by local governing codes, provide tray type suitable for plenum environments.
- .11 Test MI cables after installation, in strict accordance with cable manufacturer's instructions. Megger terminations to check that insulation resistance is acceptable to cable manufacturer. Prior to completing each termination, test insulation resistance and follow cable manufacturer's drying procedures until resistance reaches cable manufacturer's listed acceptable level.
- .12 Provide for cable manufacturer's authorized representative to review the installation, termination and testing of installed cables. Prepare report consisting of test sheets with results of cables tested and a certificate of verification signed by testing engineer/technician. Report to include copy of cable manufacturer's signed inspection letter documenting that work was performed to satisfaction of manufacturer. Submit minimum 3 hard copies and electronic copy to Consultant.

3.5 **INSTALLATION OF CORFLEX CABLES**

- .1 Provide type RA90 (Corflex II) type cables for applications as required. Handle, install, and terminate in accordance with manufacturer's recommendations and instructions and as herein specified.
- .2 Coordinate provision of Corflex II cables between genset alternator box and control panel, with genset supplier and controls Contractor.
- .3 Provide system of cable tray and Unistrut Corporation channel support system for overhead suspended Corflex II cable. Support system to consist of non-ferrous cable trays supported by channels, supported by suitable threaded steel rods secured to structure with suitable aluminum clips.
- .4 Tie wraps are not acceptable for securing Corflex II cables. Utilize non-ferrous single screw cable clamps.
- .5 Ground and bond single conductor Corflex II cables at both ends where sheath currents do not affect cable ampacity. For certain areas, where sheath currents will reduce cable ampacity, ground and bond cable at supply end and isolate cable at load end as recommended by cable manufacturer, and provide a No. 3/0 green TW ground conductor for each cable run. Refer to requirements of local governing electrical code.

3.6 **INSTALLATION OF TECK CABLES**

- .1 Provide cables as required for specific applications. Handle, install, and terminate in accordance with manufacturer's recommendations and instructions and as herein specified.
- .2 When pulling cable, apply pulling tension to conductor not in sheath of cable. Limit cable pulling tension to as recommended by cable manufacturer.
- .3 Terminate cable in equipment with lugs and termination kits as per cable manufacturer's instructions.
- .4 Installation of cable splices and terminations to be made by personnel skilled in this type of work.
- .5 Ground shielding as per cable manufacturer's instructions.
- .6 Take necessary precautions when handling cable on reel to ensure that no damage will result in uncoiling process.
- .7 No splices are allowed unless justified by cable pulling tension calculations and approved in writing by Consultant. Obtain approval of splice location from Consultant.

END OF SECTION

Appendix – Voltage Drop Schedules

Maximum Branch Wiring Distance for 120 Volt System At 3% Voltage Drop

WIRE SIZE	BREAKER SIZE (AMPERES)	15	20	30	40	50	60	70	80	100
	MAX LOAD AT 80% (AMPERES)	12	16	24	32	40	48	56	68	80
No. 12	-	24.4	18.3	-	-	-	-	-	-	-
No. 10	-	38.1	29.0	19.1	-	-	-	-	-	-
No. 8	-	59.4	44.2	30.5	22.9	-	-	-	-	-
No. 6	-	91.4	70.1	47.2	35.1	28.2	23.6	-	-	-
No. 4	-	-	109.7	73.2	54.9	42.7	38.1	32.0	27.4	-
NO. 2	-	-	-	114.3	85.3	68.6	57.9	50.3	41.1	35.0
No. 1	-	-	-	-	103.6	85.3	73.2	61.0	54.9	43.4
No. 1/0	-	-	-	-	128.0	102.9	85.3	73.2	64.0	48.8
No. 2/0	-	-	-	-	-	121.9	100.6	86.9	74.7	60.9
No. 3/0	-	-	-	-	-	-	118.1	102.1	88.4	70.1
No. 4/0	-	-	-	-	-	-	-	120.4	102.9	83.8
250 MCM	-	-	-	-	-	-	-	-	114.3	91.4
300 MCM	-	-	-	-	-	-	-	-	-	103.6

Note: Distances indicated in metres from panel to load for single phase.

END OF APPENDIX

1 General

1.1 SUBMITTALS

- .1 Submit shop drawings for products and accessories.

2 Products

2.1 BASIC MATERIALS

- .1 Ground Rods: Copper-clad steel, 20 mm (3/4") diameter circular cross-sectionalized, with driving cap and bronze tip, overall length of 3 m (10') long.
- .2 Ground Conductors: Solid copper, insulated and bare to suit application and code requirements; and bond conductors.
- .3 Ground Busbar: Solid copper busbar, predrilled for two-hole lug connections, of size of 50 mm x 9 mm x 900 mm (2" x 3/8" x 36"), for wall and backboard mounting using standoff insulators.
- .4 Ground Connections:
- .1 Below Grade: Cadweld as supplied by Erico Products or approved equal, exothermic-welded type connectors.
- .2 Above Grade or in Manholes: Compression type connectors; Exothermic connections permitted above grade if approved by Consultant.
- .3 When making ground and bonding connections, apply a corrosion inhibitor to contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between metals used.
- .5 Ground Pit: Flush in grade grounding pits with following features:
- .1 removable cast concrete cover with recessed lifting handle;
- .2 cast iron or precast concrete pit;
- .3 ground rod, ground clamps and grounding conductors as required;
- .4 clay sewer tile for proper drainage.
- .6 Gravel/Stones: Provide gravel and crushed stones as required by local governing authorities to suit application. Layers to be of thickness not less than required by local governing authorities.
- .7 Miscellaneous ancillary components to complete grounding and bonding work to requirements of local governing electrical authority and codes.

2.2 TELECOMMUNICATIONS

- .1 Telecommunications Equipment Rack And Cabinet Ground Bars: solid copper ground bars designed for mounting on framework of open or cabinet-enclosed equipment racks with minimum dimensions of 6 mm (1/4") thick by 20 mm (3/4") wide; At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks. Where bolting to painted surfaces, use paint piercing type washers.
- .2 LAN Room Ground Bus: 50 mm x 9 mm x 300 mm (2" x 3/8" x 12") copper ground bus with eight (8) drilled taped holes; mounted on walls with standoff insulators.
- .3 Ground Conductor for Grounding Grid and Associated Connections: Number 3/0 AWG bare, 7-strand medium hard-drawn copper unless indicated otherwise.

- .4 Ground Braid: constructed from flat 98% conductivity tinned copper grounding braid.

3 Execution

3.1 **GENERAL GROUNDING AND BONDING REQUIREMENTS**

- .1 Provide required grounding and bonding work in accordance with drawings, local governing electrical authority, governing authorities having jurisdiction and local governing electrical inspection authority. Confirm requirements with local governing electrical utility.
- .2 Perform ground resistivity testing of soil to determine measurement expressed in ohm meters as defined by IEEE 80-2000 - IEEE Guide for Safety in A.C. Substation Grounding. Use 4-point method with Model 4610 or Model 4500 Ground Tester or equal, and insertion of four equally spaced and in-line electrodes into test area.
- .3 Provide applicable high voltage grounding requirements in accordance with local governing electrical code and requirements identified in issued Documents.
- .4 Provide a ground electrode consisting of minimum four (4) ground rods (unless otherwise detailed or otherwise required by local governing electrical code) driven into grade in an arrangement as required and interconnected with minimum No. 3/0 bare copper conductor.
- .5 Drive and bury ground rods at depth in accordance with local governing electrical code.
- .6 Connect station equipment to ground electrode with 2 runs of minimum No. 3/0 bare copper conductor.
- .7 Provide 50 mm x 9 mm x 900 mm (2" x 3/8" x 36") electrical grade copper ground bus on perimeter wall of electrical rooms, 300 mm (12") above finished floor level. Secure ground bus on 20 mm (3/4") standoff insulators. Connect electrical rooms ground grid with ground bus with minimum 3/0 copper ground conductor in conduit. Connect each electrical room perimeter ground electrode system back to main electrical room ground electrode with minimum No. 3/0 copper conductors.
- .8 Ground and bond other equipment such as transformers, switchboards, panelboards, and similar metal work to perimeter ground bus. Provide minimum No. 3/0 insulated ground wire from ground bus in electrical rooms to switchboards, transformers, structure, floor, etc.
- .9 Extend conductors to metal piping of main water service and connect ground conductor to street side of water meter. If piping is not metallic, make necessary connections as required by local governing electrical utility.
- .10 Effectively bond metallic pipe services such as, gas mains, water mains, and dry risers, to main grounding terminal at their point of entry. Make connections to services with purpose-made grounding clamps.
- .11 When buses are in place, bolts have been tightened, and lugs have been installed, coat entire installation with two (2) 100% covering coats of suitable shellac to prevent bus from oxidizing.
- .12 Throughout complex, solidly ground systems and make required grounding connections to electrical devices and apparatus. Ground conductors to be insulated copper wire connected with approved fittings in accordance with local governing electrical code.
- .13 Effectively bond building structures to main grounding system (grid).

- .14 Connect grounding conductors to motors 10 hp and above or circuits 20A or above, with a solderless terminal and a bolt tapped to motor frame or equipment housing. Connect to smaller motors or equipment by fastening terminal to a connection box. Connect junction boxes to equipment grounding system with grounding clips mounted directly on box or with machine screws. Completely remove paint, dirt, or other surface coverings at grounding conductor connection points so good metal-to-metal contact is made.
- .15 Ground metal sheathing and any exposed metal vertical structural elements of buildings. Ground metal fences enclosing electrical equipment. Bond any metal equipment platforms which support electrical equipment to equipment ground. Bond rooftop equipment.
- .16 Provide separate ground connection for bathtubs.
- .17 Provide service conductors exceeding 400 amperes with minimum No. 3/0 AWG grounding conductors, unless otherwise noted.
- .18 Ground and bond various telecommunications, audio visual systems, security, life safety and control systems in accordance with respective system manufacturers recommendations and in accordance with local governing electrical code requirements.
- .19 Make ground connections in slab or buried underground using local governing electrical authority approved welded copper connections.
- .20 Provide minimum no. 3/0 AWG insulated copper ground conductors and LAN Room copper ground bus mounted on walls with standoff insulators in each LAN room. Connect ground bus to computer equipment racks and to building ground system.
- .21 Ground conductors not sized on drawings are to be sized in accordance with local governing electrical authority requirements. Ground conductor size is to be no smaller than requirements specified herein this article or on drawings.

3.2 **ADDITIONAL TELECOMMUNICATIONS GROUNDING**

- .1 Comply with TIA/EIA-607 grounding and bonding requirements.
- .2 Provide wire and hardware required to properly ground, bond, and connect communications raceway, cable tray, metallic cable shields, and equipment to a ground source.
- .3 Ground bonding jumpers to be continuous with no splices. Use shortest length of bonding jumper possible.
- .4 Provide ground paths which are permanent and continuous with a resistance of 1 ohm or less from raceway, cable tray, and equipment connections to building grounding electrode. Resistance across individual bonding connections to be 10 milliohms or less.
- .5 Bonding Jumpers:
 - .1 Use insulated ground wire of size and type if identified on Drawings if not identified, comply with local governing code, but which is to be a minimum of No. 6-AWG insulated copper wire.
 - .2 Assemble bonding jumpers using insulated ground wire terminated with compression connectors.
 - .3 Use compression connectors of proper size for conductors specified. Use connector manufacturer's compression tool.
- .6 Bonding Jumper Fasteners:

- .1 Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten plain end of a bonding jumper wire by slipping this plain end under conduit strut clamp pad; tighten clamp screw firmly. Where appropriate, use zinc-plated external tooth lockwashers.
- .2 Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers, and nuts. Install protective cover; e.g., zinc-plated acorn nuts, on any bolts extending into wireway or cable tray to prevent cable damage.
- .3 Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lockwashers, and nuts.
- .4 Unistrut and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lockwashers.
- .7 Building Ground Busbars:
 - .1 Provide busbar hardware at each communications room and connect to pigtail extensions of building grounding ring.
 - .2 Verify that ground ring pigtail is same type and size conductor used for main building grounding ring.
- .8 Telecommunications Ground Busbars:
 - .1 Provide communications room telecommunications ground busbar hardware at cable tray height.
 - .2 Connect busbar to building ground busbar located in same room using two-hole compression lugs and a grounding jumper of same size as pigtail extension of main building grounding ring (usually 3/0 AWG).
- .9 Ground metallic conduits, wireways, and other metallic equipment located away from equipment racks or cabinets to cable tray pan or telecommunications ground busbar, whichever is closer, using insulated No. 6-AWG ground wire bonding jumpers.
- .10 Ground metallic conduit at each end using No. 6-AWG bonding jumpers.
- .11 Comply with cable tray manufacturer's grounding and bonding recommendations. Bond metallic structures of wireway to provide 100% electrical continuity throughout wireway system.

END OF SECTION

1 General

1.1 SUBMITTALS

- .1 Submit as part of shop drawing submission, copies of:
 - .1 electrical distribution system protective device coordination study and short circuit calculations;
 - .2 arc flash analysis report.
- .2 Submit electrical distribution system coordination study and short circuit calculations reports prior to or with proposed shop drawings of major electrical distribution equipment. Allow in shop drawing process, sufficient time for Consultant to review and make comments and for Contractor and equipment vendors to incorporate Consultant comments, necessary revisions and results of reports into equipment shop drawings. Do not order equipment until shop drawings are acceptable to Consultant. Time for this shop drawing review process will be at Consultant's discretion, but typically allow for 15 working days for initial review submission with additional 10 working days added to accommodate each resubmission.
- .3 If formal completion of studies and reports may cause delay in equipment manufacture, approval from Consultant may be obtained for preliminary submittal of sufficient data to ensure that selection of device ratings and characteristics will be satisfactory. Subsequently, provide formal studies and reports to verify preliminary findings.
- .4 Submit after completion of factory testing, copies of completed product testing reports.
- .5 Submit after installation and testing, copies of:
 - .1 completed testing reports with completed test results sheets;
 - .2 certificate of approvals from local governing authorities, manufacturers' of systems and equipment and testing companies.
- .6 Verify form of submittals (submission procedures, number of hard copies and requirements for electronic copies) with Consultant at project start-up. For pricing assume minimum 3 hard coloured copies bound and electronic pdf copy.

2 Products

2.1 GENERAL SCOPE OF WORK

- .1 Include for but not be limited to following:
 - .1 preparing and submitting preliminary coordination study and short circuit calculations and recommendations on required relays, sensors and CT's for proper system coordination and protection;
 - .2 preparing and submitting arc flash study with calculations for use in determining required electric shock and arc flash protection;
 - .3 product manufacturers providing equipment inspection, testing, start-up, adjustments and verification;
 - .4 independent 3rd party testing of electrical distribution system equipment and associated products;
 - .5 independent 3rd party testing of systems and equipment as noted;

- .6 electricians/trades people on site to handle equipment, make temporary connections, operate equipment and make repairs and adjustments and assist manufacturer's / testing organization's personnel during on-site inspection, testing, calibration, start-up, verification work and where supplementary commissioning;
- .7 coordination of work with testing company and equipment/system manufacturer's authorized technician in performing adjustments and start-up procedures to equipment/systems;
- .8 preparing testing reports and documentation for submission to Consultant.

3 Execution

3.1 **PRELIMINARY COORDINATION STUDY AND SHORT CIRCUIT CALCULATIONS**

- .1 Immediately after award of Contract liaise with local electrical supply authority for information on relays and other protective devices installed on their system and substations which affect co-ordination of site electrical distribution system.
- .2 Immediately after award of Contract liaise with proposed manufacturer of electrical distribution equipment to obtain appropriate information and recommended devices to obtain co-ordination of electrical distribution system.
- .3 Prepare preliminary coordination study and calculate available fault currents. Combine into preliminary report and submit minimum one hard copy and electronic copy to Consultant for review.
- .4 Prepare report to typical standards as specified in respective coordination study and short circuit calculation report articles in this Section.

3.2 **DISTRIBUTION SYSTEM COORDINATION STUDY AND SHORT CIRCUIT CALCULATIONS**

- .1 Prepare coordination study and short circuit calculations (available fault currents) of system. Perform work to standards of applicable local governing authorities, local electrical inspection authority and CSA Standards.
- .2 Submit coordination study and short circuit calculations reports as part of shop drawing submission as specified in Part 1 article - Submittals. Ensure that results and Consultant's reviewed comments from these reports are incorporated into electrical distribution equipment shop drawings.
- .3 Protective system devices have been selected such that protection is adequate and good coordination is possible, however, since differences do exist between manufacturers, some changes in trip ratings or relay settings may be necessary and are to be carried out. Obtain local electrical utility information on their protective devices and include requirements as necessary.
- .4 Provide and carry out following:
 - .1 prepare a set of coordination curves on K.E. No. 336E Time Current Characteristic graph paper;
 - .2 this is to be accompanied by supporting symmetrical as well as asymmetrical fault current calculation data with tabulations to verify protection of various elements of systems under maximum and minimum fault conditions at various points in systems.
 - .3 Plot time-current characteristic curves for following:

- .1 main and feeder protective devices at voltage levels used in distribution system;
- .2 protective devices associated with largest motor in each MCC, refrigeration machine compressors and largest device in each distribution panel;
- .3 motor generator protective devices, damage curves and current decrement curves.
- .5 Cooperate with and obtain from other manufacturers a list of equipment requiring protective devices to be used in distribution system and prepare coordination curves as soon as possible. Be responsible, along with other manufacturers' equipment connected to distribution system, to ensure that proper control and protective devices are selected such that they coordinate with protective devices.
- .6 It is responsibility of equipment manufacturers to examine plans and specifications to ensure that relays and protective devices being installed in distribution system provide satisfactory coordination.
- .7 Where automatic transfer switches are provided, submit coordination results available fault current values at locations of transfer switches, to transfer switch manufacturer to ensure that transfer switches provided are of suitable withstand current ratings.
- .8 Document testing, coordination study and arc flash analysis in a report signed by a Professional Engineer licensed in the Place of Work and authorized by testing company. Include for minimum 3 hard copies and electronic copy of report to be submitted to Consultant for review. Report to include test results with properly plotted curves, identified trouble areas of coordination, extensive comments regarding test results and recommendations on best course of remedial action.
- .9 Acceptable companies to provide this work are to be successful manufacturer of electrical distribution system equipment and include:
 - .1 Eaton Electric Services Division;
 - .2 Schneider Electric Services Division;
 - .3 Siemens Electric Services Division.

3.3 GENERAL ELECTRICAL WORK TESTING

- .1 In addition to tests required by local governing authorities having jurisdiction, local codes and regulations, perform following:
 - .1 after luminaires, switches, receptacles, motors, signals, etc., are installed, whether same are installed as part of this Division or by other Divisions (telephone systems excepted), test work to ensure that there are no leaks, grounds or crosses;
 - .2 establish and ensure proper motor rotation - measure full load running currents and check overload elements - report to Consultant any discrepancies which are found; existing motors which have been worked on (disconnected and reconnected) must be checked with rotation meter to ensure proper rotation; be responsible for any damage caused by reverse rotation;
 - .3 demonstrate to Consultant that branch circuit voltage drop is within specified units;
 - .4 ensure that devices are commissioned and operable.

- .2 Document results into distribution system testing report. Report must state that testing was successful and Work complies with project documents, applicable CSA standards, and other applicable governing codes and requirements.

3.4 **SYSTEMS INSPECTION, TESTING, START-UP AND VERIFICATION**

- .1 When each system and each major piece of equipment installation is complete and ready for acceptance, include for system and equipment manufacturer or manufacturer's authorized representative to visit site to provide system inspection, testing, start-up, and verification. Perform following:
 - .1 check component connections and overall installation;
 - .2 adjust sound systems for high quality, distortion free performance, free from noise, cross-talk, hum or other interference;
 - .3 test and adjust system and ascertain that components are as specified and ensure that products operate as designed;
 - .4 provide start-up procedures for systems and equipment;
 - .5 verify and certify system component operations;
 - .6 prepare, document and evaluate test results;
 - .7 authenticate test results with signature of authorized testing Engineer/Technician;
 - .8 check and verify nameplates;
 - .9 provide maintenance and operating instructions to Owner's personnel.
- .2 Perform work properly documented, and in accordance with manufacturer's instructions and recommendations.
- .3 Perform work under presence of Owner/Consultant/Commissioning Agent at times approved by Owner and reviewed with Consultant.
- .4 Provide these requirements after each phase (as applicable) to allow Owner option to use area of phase of work. These requirements are also to be provided prior to applying for Certificate of Substantial Performance of the Work of project.
- .5 Include for manufacturers authorized technicians of equipment/systems integrated to equipment/systems being tested to be onsite during full integration testing. Coordinate with each manufacturer.
- .6 When system inspection, testing, start-up and verification specified above is complete, obtain from supplier/manufacturer (or where specified, independent inspection company) a test report with test sheets, and covering verification letter signed by authorized testing technician, stating that system or equipment has been inspected and tested, performs as specified and is ready for acceptance. Include date and time of testing, testing technician's name and specification section number test fulfilled.
- .7 Bind documents under cover and submit minimum one hard copy and electronic copy to Consultant.

3.5 **GROUND POTENTIAL RISE STUDY**

- .1 Prepare a ground potential rise (GPR) study to ensure that ground system complies with requirements of local governing electrical code, for protection of personnel and equipment. GPR study to include but not be limited to:
 - .1 site review of ground system;
 - .2 soil resistivity test;

- .3 computer modelled ground system design;
- .4 safety calculations and recommendations;
- .5 GPR calculations and written report.
- .2 Perform ground resistivity testing of soil to determine measurement expressed in ohm-meters as defined by IEEE 80-2000 - IEEE Guide For Safety In A.C. Substation Grounding. Use 4-point method with Model 4610 or Model 4500 Ground Tester or approved equal, and insertion of four equally spaced and in-line electrodes into test area.
- .3 Include date and time of testing, testing technician's name and signature. Bind documents under cover with distribution system testing report and submit minimum one hard copy and electronic copy to Consultant.
- .4 Acceptable companies to prepare study to be as listed for distribution system testing and coordination study work.

3.6 **ELECTRICAL DISTRIBUTION SYSTEM TESTING AND VERIFICATION**

- .1 Provide services consisting of on-site engineering inspection, testing and verification of electrical distribution equipment and other systems and equipment. Perform work to standards of applicable local governing authorities, local electrical inspection authority and CSA Standards.
- .2 Services to be performed by an approved independent testing company and be initially conducted prior to system/equipment being energized and further testing when energized, and include following items, where applicable:
 - .1 testing, cleaning when necessary, and calibrating relays and circuit breaker trip devices (calibration of protective devices to conform to requirements of approved coordination curves);
 - .2 function test of associated control devices;
 - .3 replacement of fuses destroyed during testing;
 - .4 an acceptance test in presence of Consultant;
 - .5 presence, for length of time required, of qualified and competent equipment manufacturer's service representative during start-up;
 - .6 carry out insulation resistance testing of outgoing feeders with respect to ground;
 - .7 inspection and testing of cables, power panels, lighting panels, transformers, power receptacles and switches;
 - .8 inspection and testing of electrical system auxiliary systems and devices such metering, power factor capacitors, transfer switches, generators sets and load banks;
 - .9 inspection and testing of starters and variable frequency drives;
 - .10 inspection and testing of lighting control systems including central control systems, low voltage relays, sensors and dimming controls; ensure that devices perform in conformance with ASHRAE 90.1 requirements;
 - .11 verification and certification work of equipment and systems;
- .3 Perform services procedures properly documented, and in accordance with manufacturer's instructions and recommendations.
- .4 Forward to Consultant for review, minimum 3 hard copies and electronic file of engineering and testing report.

- .5 Where relays, breakers, etc., do not perform to Consultant reviewed coordination curves, revise as part of work.
- .6 Test high voltage cable installation before placing in regular service. Work includes phase verification, grounding verification, hi-pot test of insulation strength to IPCEA Specifications (Leakage Curves to be obtained), and time domain reflectometer tests to give records of cable impedance profiles to draw attention to cable damage. Reference cable manufacturers testing procedures and do not exceed maximum test voltage levels and durations.
- .7 Testing organization to report high voltage cable defects directly to Consultant as soon as such defects are discovered. Re-test affected cables after proper repair. Also, re-test cables in cases where cable damage after installation is suspected. On completion of satisfactory testing of installation, submit a report by testing organization stating that cables concerned have satisfactorily passed required tests and are suitable for service. Submit report for Consultant's review. Submit recorded test data (properly bound) with report, in each case.
- .8 Test main power transformers before placing in regular service. Work to include voltage ratio test, phase angle test, insulation resistance, oil sampling (liquid type transformer), start-up and other manufacturer's recommended tests.
- .9 Provide testing and coordination of emergency power distribution system to ensure that system performs in accordance to latest requirements of CSA Standard C282. Ensure that engine-generator set manufacturer and testing and coordination companies co-operate to ensure that CSA requirements are fulfilled. Provide necessary adjustments and coordination to ensure that emergency power distribution system transfers essential loads to emergency power within required response time of loss of normal power.
- .10 Provide visual and mechanical inspection of ground system and verify that it is in compliance with issued documents and local governing electrical code requirements.
- .11 Perform fall-of-potential test or alternative in accordance with IEEE Standard 81 on main grounding electrode or system in order to determine current status, possible grounding contamination and proper ground resistance value. Perform point-to-point tests to determine resistance between main grounding system and major electrical equipment frames system neutral, and/or derived neutral points. Resistance between main grounding electrode and ground is not to be greater than 5 ohms for commercial or industrial systems and 1 ohm or less for generating or transmission station grounds unless otherwise specified. (Reference: ANSI/IEEE Standard 142). Investigate point-to-point resistance values which exceed 0.5 ohm.
- .12 Additionally, perform testing of lighting control systems and devices to ensure conformance with ASHRAE 90.1 requirements.
- .13 Document testing, coordination study and arc flash analysis in a report signed by a Professional Engineer licensed in the Place of Work and authorized by testing company. Include for minimum 3 hard copies and electronic copy of report to be submitted to Consultant for review. Report to include test results with properly plotted curves, identified trouble areas of coordination, extensive comments regarding test results and recommendations on best course of remedial action.
- .14 Acceptable companies to provide this work are to be independent of successful manufacturers providing distribution system equipment and include:
 - .1 Eaton Electric Services Division;
 - .2 Schneider Electric Services Division;
 - .3 Siemens Electric Services Division.

3.7 SHOCK AND ARC FLASH PROTECTION

.1 General:

- .1 Provide for electric shock and arc flash protection as required by local governing electrical code and local governing authorities.
- .2 Determine severity of potential exposure, planning safe work practices and selecting personal protective equipment under general guidelines of governing edition of CSA Z462.
- .3 Design safety signs and labels for applications to equipment under general guidelines of ANSI Z535.4.
- .4 Determine arc flash hazard distance and incident energy that workers may be exposed to from electrical equipment under general guidelines of IEEE 1584.
- .5 Incorporate documentation with distribution system testing and coordination study report.
- .6 Acceptable companies to provide this work are to be successful manufacturer of electrical distribution system equipment and include:
 - .1 Eaton Electric Services Division;
 - .2 Schneider Electric Services Division;
 - .3 Siemens Electric Services Division.

.2 Arc Flash Hazard Analysis:

- .1 Perform Arc Flash Hazard analysis according to IEEE 1584 equations that are presented in NFPA70E, Annex D.
- .2 Retrieve short circuit calculations and clearing times of phase overcurrent devices from short circuit and coordination study specified previously.
- .3 Calculate flash protection boundary and incident energy at significant locations in electrical distribution system (switchboards, switchgear, panelboards, busway and splitters) where work could be performed on energized parts.
- .4 Arc-Flash Hazard Analysis to include significant locations in 240 V and 208 V systems fed from transformers equal to or greater than 125 kVA.
- .5 Specify safe working distances for calculated fault locations based upon calculated arc flash boundary considering incident energy of 1.2 cal/cm².
- .6 Include Arc Flash Hazard analysis calculations for maximum and minimum contributions of fault current magnitude. Minimum calculation to assume that utility contribution is at a minimum and a minimum motor load. Conversely, maximum calculation to assume a maximum contribution from utility and motors to be operating under full-load conditions. Other switching scenarios are to be included as necessitated by power system design and layout.
- .7 Arc Flash computation to include both line and load side of main breaker calculations, where necessary.
- .8 Base Arc Flash calculations to be based on actual overcurrent protective device clearing time. Cap maximum clearing time at 2 seconds based on IEEE 1584 section B.1.2.

.3 Arc Flash Warning Labels:

- .1 Provide minimum 90 mm x 127 mm (3.5" x 5") thermal transfer type label of high adhesion polyester for each work location analysed.

- .2 Label to have an orange header with wording, "WARNING, ARC FLASH HAZARD", and include following information:
 - .1 location designation;
 - .2 nominal voltage;
 - .3 flash protection boundary;
 - .4 hazard risk category;
 - .5 incident energy;
 - .6 working distance;
 - .7 engineering report number, revision number and issue date.
- .3 Machine print labels with no field markings.
- .4 Provide Arc Flash labels for following equipment (as applicable to project and required by codes and standards) and base labels on recommended overcurrent device settings:
 - .1 panelboards;
 - .2 VFDs;
 - .3 distribution transformers;
 - .4 switchboards;
 - .5 transfer switches;
 - .6 genset control equipment;
 - .7 switchgear;
 - .8 medium voltage switches and breakers;
 - .9 other equipment as required by local governing authorities.

3.8 INFRARED SCANNING

- .1 Provide infrared scanning of Work and connections to electrical distribution equipment as noted.
- .2 Infrared scanning process to include but not be limited to following:
 - .1 use of latest technology infrared fast scanning thermal imaging camera with colour digital conversion thermographic imaging capabilities; camera to be capable of determining temperature differences using generated isotherms;
 - .2 scanning distribution system with ability to detect 1°C between subject area and reference at 30°C;
 - .3 equipment to detect emitted radiation and convert detected radiation to visual image;
 - .4 infrared surveys to be performed during periods when equipment is under intended full operating load;
 - .5 perform scanning of essential power equipment when gensets are in operation and essential power is on line.
- .3 Some guidelines for interpretation of temperature gradients are:
 - .1 temperature gradients of 3°C to 7°C indicate possible deficiency and warrant investigation;

- .2 temperature gradients of 7°C to 15°C indicate deficiency; required repair as time permits as directed by Consultant;
- .3 temperature gradients of 16°C and above indicate major deficiency; requires repair immediately.
- .4 Document testing in a report signed by a Professional Engineer licensed in the Place of Work and authorized by testing company. Include for minimum 3 hard copies and electronic copy of report to be submitted to Consultant for review. Report to include but not be limited to include:
 - .1 indication of problem area (location of "hot spot");
 - .2 indication of temperature rise between "hot spot" and normal or reference area;
 - .3 indication of cause of heat rise;
 - .4 indication of phase unbalance, if present;
 - .5 indication of areas scanned;
 - .6 colour photographs and thermograms of deficient area as seen on imaging system;
 - .7 summary of work;
 - .8 list of test equipment;
 - .9 faults, corrections required, recommendations;
 - .10 retesting of corrected faults.
- .5 Acceptable infrared scanning companies:
 - .1 Predictive Technology;
 - .2 GT Wood;
 - .3 Pelikan Inc.

END OF SECTION

- 1 General
- 1.1 **APPLICATION**
 - .1 This Section specifies commissioning requirements that are common to electrical work Sections of Specification and it is a supplement to each Section and is to be read accordingly.
- 1.2 **REFERENCE**
 - .1 Refer to commissioning requirements specified in Division 01.
- 1.3 **COMMISSIONING AGENT INVOLVEMENT VERSUS WARRANTY OBLIGATIONS**
 - .1 Involvement of Commissioning Agent performing duties as described in this Section is not in any way to void or alter any Contractual warranty obligations.
- 1.4 **SUBMITTALS**
 - .1 Submit to Commissioning Agent, at same time as submittal to Consultant, one copy of each shop drawing or product data sheet associated with equipment or systems to be commissioned.
 - .2 Submit for review, a Commissioning Plan with schedule, commissioning procedures for commissioning events, and a copy of Commissioning Agent's commissioning data sheets for equipment/systems to be commissioned.
 - .3 Submit a list of commissioning instruments and for each instrument, indicate purpose of instrument and include a recent calibration certificate.
 - .4 Submit equipment and system manufacturer's start-up and test report sheets for review a minimum of one month prior to equipment and system start-up procedures.
 - .5 After start-up and successful pre-functional performance testing and submittal of completed forms, submit, for each system or subsystem, a letter to confirm that pre-functional performance testing has been successfully completed and system or subsystem is ready for functional performance testing and commissioning process to commence.
- 1.5 **DEFINITIONS**
 - .1 Commissioning: process of demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, as further described below.
 - .2 Commissioning Agent: commissioning authority who will supervise commissioning process, and who will recommend final acceptance of commissioned electrical work.
 - .3 Start-Up and Adjusting: process of equipment manufacturer's/supplier's technical personnel, with Contractor, starting and operating equipment and systems, making any required adjustments, documenting process, and submitting manufacturer's/supplier's start-up reports to confirm that equipment has been properly installed and is operational as intended.

- .4 Pre-Functional Performance Testing: testing, adjusting and operating of components, equipment, systems and/or subsystems, by Contractor, after start-up but before functional performance testing, to confirm that components, equipment, systems and/or subsystems operate in accordance with requirements of Contract Documents, including modes and sequences of control and monitoring, interlocks, and responses to emergency conditions, and including submittal of pre-functional performance testing documentation sheets.
- .5 Functional Performance Testing: a repeat of successful pre-functional performance testing by Contractor, in presence of Commissioning Agent and Consultant with completed Commissioning Agent's commissioning documentation sheets to document, validate, and verify that equipment, systems and subsystems are complete in all respects, function correctly, and are ready for acceptance.
- .6 Commissioning documentation sheets: prepared sheets for pre-functional performance testing and for functional performance testing supplied by Commissioning Agent for each piece of equipment/system to be commissioned, each sheet or set of sheets complete with Project name and number, date of commissioning, equipment/system involved, equipment/system name and model number, equipment identification as per drawings, and, for each commissioning procedure listed, a column giving expected data as per Contract Documents, a column to fill in observed data during commissioning, and space for signatures of Contractor and Commissioning Agent.
- .7 Systems Operating Manual: a manual prepared by Commissioning Agent to present an overview of building electrical systems and equipment to be used by building maintenance personnel to assist them in daily operation of systems.
- .8 Validate: to confirm by examination and witnessing tests correctness of equipment and system operation.

1.6 **COMMISSIONING AGENT**

- .1 Retain services of a qualified Commissioning Agent.

1.7 **QUALITY ASSURANCE**

- .1 Commissioning work is to be in accordance with requirements of following:
 - .1 Z320, Building Commissioning Standard & Check Sheets;
 - .2 ASHRAE Guideline 0, The Commissioning Process;
- .2 Commissioning Agent is to meet following qualifications:
 - .1 be a member of Professional Engineers Association in the Province of the Work;
 - .2 be a member of Building Commissioning Association, and a Certified Commissioning Professional (CCP) as designated by Building Commissioning Association;
 - .3 have a minimum of five years of successful documented commissioning experience on projects of similar size and complexity as this Project;
 - .4 supply a qualified P. Eng. and a Building Commissioning Association Certified Commissioning Professional (CCP) or an ASHRAE Commissioning Project Management Professional (CPMP) on site to supervise commissioning process.

1.8 **COMMISSIONING OBJECTIVES**

- .1 Objectives of commissioning process are as follows:
 - .1 to support quality management by means of monitoring and checking installation;

- .2 to verify equipment/system performance by means of commissioning of completed installation;
- .3 to move completed equipment/systems from "static completion" state to "dynamic" operating state so as to transfer a complete and properly operating installation from Contractor to Owner.

1.9 **TESTING EQUIPMENT**

- .1 Supply instruments and test equipment required to conduct start-up, testing and commissioning procedures.

2 **Products**

2.1 **NOT USED**

3 **Execution**

3.1 **COMMISSIONING**

- .1 Commission work in accordance with requirements of this Section and as required by Commissioning Agent.
- .2 Prerequisites to successful completion of commissioning are as follows:
 - .1 submittal of signed start-up and test reports;
 - .2 completion of electrical distribution system testing and coordination study;
 - .3 permanent electrical and control connections of equipment;
 - .4 successful completion and documentation of pre-functional performance testing;
 - .5 submittal of letters to Consultant certifying that systems and subsystems have been started, tested, adjusted, successfully pre-functional performance tested, are ready for functional performance testing, and are in accordance with requirements of Contract Documents.

3.2 **DEFICIENCIES LISTED DURING COMMISSIONING**

- .1 Correct deficiencies listed by Consultant and Commissioning Agent during commissioning process within 15 calendar days of notification unless agreed otherwise with Consultant, and when deficiencies have been corrected, notify Consultant and Commissioning Agent.

3.3 **SYSTEMS TO BE COMMISSIONED**

- .1 Electrical systems to be commissioned include systems as specified in Electrical Divisions of Specification. Specific commissioning procedures are to be as directed by Commissioning Agent. General commissioning procedures for typical equipment and systems include but are not limited to:
 - .1 Distribution Cables:
 - .1 Check for correct cable installation and termination.
 - .2 Check and record cable sizes, types and method of installation.
 - .3 Check and confirm installed cable sizes are of adequate rating, taking into consideration of type of cable, method of installation, correction factors and any other Code requirements.

- .4 Grounding test to ensure equipment, conduit and cable armour/sheath, if applicable, are properly grounded.
- .5 Perform tests as required by Commissioning Agent.
- .2 Gensets:
 - .1 Check and record alternator, engine, control panel, switchboard, and battery nameplate data.
 - .2 Check and ensure that generator installation, grounding system, associated supply and exhaust air system, fuel system and room are completed prior to carrying out test.
 - .3 Complete generator installation is to be completed prior to carrying out generators site tests. Installations include generators, electrical installation, fuel supply system, ventilation system, exhaust system, automatic control and indication systems, and interface with other systems installations.
 - .4 Test protective devices and circuits on site by actually simulating a fault condition on devices.
 - .5 Test interfaces with transfer switches for correct starting, power transfer, retransfer, and shut down of generators after power is restored.
 - .6 Test interface controls and indications with building management system, fire alarm system, elevator control system and any other systems as specified.
 - .7 Dummy load test at full load operation.
 - .8 Test paralleled units, with dummy loading on generators to be shared amongst generators.
 - .9 Load test generators in accordance with CSA C282, Z32 (for Healthcare projects) and Z8001.
 - .10 Check sound level at various loads.
 - .11 Perform tests as required by Commissioning Agent.
- .3 Auto Transfer Switches:
 - .1 Check and record nameplate data.
 - .2 Check and test switch for correct alignment and correct mechanical operation of switch in different positions.
 - .3 Test electrical control, indication and interface signals with generators, fire alarm panel, elevator control panels, building management panel or other interface panels.
 - .4 Test for correct phase sequence and voltage.
 - .5 Perform interface test with generator for starting and stopping, in accordance with CSA Z32 (Healthcare projects).
 - .6 Perform tests as required by Commissioning Agent.
- .4 Distribution Panelboards and Branch Circuit Panelboards:
 - .1 Check and record nameplate data.
 - .2 Check and test to verify panelboard directory is correct.

- .3 Include directory in test records. Directory to contain size of each breaker, equipment served, cable type and size.
- .4 Check and test voltage drop is within specified limit from service entrance switchboard to branch panelboards.
- .5 Test branch circuits voltage drop is within requirements.
- .6 Megger test branch circuits.
- .7 Perform tests as required by Commissioning Agent.
- .5 Coordination Study and On-Site Testing:
 - .1 Independent Third Party Testing Agent to prepare coordination study as specified in Specification.
 - .2 Independent Third Party Testing Agent to carry out on site testing.
 - .3 Check and measure and record prospective fault level at service entrance switchboards, motor control centres, transformers, auto transfer switches, generator switchboard and control panels; distribution panels and branch circuit panelboards.
 - .4 Record and set breakers, fuse ratings, and protection devices to ensure discrimination of electrical distribution system.
 - .5 Provide test records for measured prospective fault level and indicate fault ratings of installed equipment such as switchboards, panels, switches, breakers for above systems to confirm adequacy of fault rating of installed equipment.
 - .6 Perform tests as required by Commissioning Agent.
- .6 Lighting Systems:
 - .1 Check and verify central lighting control systems and dimming systems.
 - .2 Check and verify lighting fixtures are connected and switched properly.
 - .3 Check and verify automatic controls are connected and functioning properly.
 - .4 Check and verify emergency lighting system, including battery lighting system, are connected and functioning properly.
 - .5 Carry out lighting level tests as required and directed by Commissioning Agent.
 - .6 Perform tests as required by Commissioning Agent.
- .7 Security System and CCTV:
 - .1 Check main panels for proper installation, wiring identification, wire harnessing, and emergency power feed.
 - .2 Test and document each type of alarm from each station, noting station number(s) at which signal has been received.
 - .3 Check field devices for proper operation.
 - .4 Check for integration to other systems.
 - .5 Perform tests as required by Commissioning Agent.
- .8 Fire Alarm System:

- .1 Check and record nameplate data.
- .2 Check and report panel enclosure is suitable for environment in which it is installed.
- .3 Perform system verifications and tests according to CAN/ULC-S536 and S537.
- .4 Perform tests as required by Commissioning Agent.
- .9 Other Systems:
 - .1 Check and record nameplate data.
 - .2 Perform tests on following systems, where applicable.
 - .1 intercom system;
 - .2 network structured cabling system;
 - .3 electric heat tracing.
 - .3 In addition to requirements of Electrical Divisions, test and commission following items:
 - .1 electrical devices supplied in equipment under work of Divisions other than Electrical Divisions;
 - .2 Owner's supplied equipment as noted or directed by Consultant and/or Owner.
 - .4 Perform tests as required by Commissioning Agent.

3.4 COMMISSIONING PROCESS

- .1 Perform commissioning process in stages and include, but not be limited to, following:
 - .1 Stage 1: Commissioning of equipment/systems as listed in this Section, which is a prerequisite to an application for Substantial Performance of the Work and includes supervising and validating results of functional performance testing, and submittal of reviewed Systems Operating Manual.
 - .2 Stage 2: Commissioning work to be performed 12 months after issue of a Certificate of Substantial Performance of the Work and which includes supervision of Contractor's "fine tuning" of equipment/systems through seasonal occupancy, and any other such work to achieve optimal comfort and performance conditions.
 - .3 Stage 3: Successful completion of satisfactory equipment/system operation during first month after issue of a Certificate of Total Performance of the Work.
 - .4 Stage 4: Successful completion of satisfactory equipment/system operation during third month after issue of a Certificate of Total Performance of the Work.
 - .5 Stage 5: Successful seasonal commissioning of building.

3.5 RESPONSIBILITIES OF COMMISSIONING AGENT

- .1 During construction phase Commissioning Agent is to:
 - .1 review Contractor's shop drawings for commissioning related issues, and report any such issues to Consultant;
 - .2 as soon as possible after project start-up, prepare and issue a Commissioning Plan based on Contractor's construction schedule;

- .3 prior to tests, supply pre-functional performance test commissioning data sheets for all equipment and systems to be commissioned to Contractor;
 - .4 monitor and inspect installation on a regular basis throughout construction stages, issue reports identifying any issues which may have an impact on commissioning process, and work with project team to expeditiously resolve any problems that may arise due to site conditions;
 - .5 arrange with Contractor for on-site commissioning meetings on an as-required basis, to be attended by Contractor and applicable subcontractors, Owner, and Consultant, chair meetings, and prepare and distribute meeting minutes to all attendees;
 - .6 witness and validate tests, identify deficiencies, and issue progress reports;
 - .7 coordinate commissioning scheduling with Contractor;
 - .8 review pre-functional performance test commissioning data sheets submitted by Contractor, then witness and supervise functional performance testing and supervise and direct commissioning process, validate commissioning procedures, witness completion of commissioning data sheets by Contractor, and sign completed data sheets;
 - .9 perform a preliminary review of Contractor's O & M Manuals, before they are issued to Consultant, and issue any comments to Consultant;
 - .10 coordinate with Contractor and Owner training and instructions by Contractor and his equipment and system manufacturers/suppliers to Owner's operating and maintenance personnel, and comment on quality of training and instructions to Consultant;
 - .11 prepare and issue Systems Operation Manual to Owner prior to equipment and system training by Contractor.
- .2 During post construction phase Commissioning Agent is to:
- .1 prepare and issue final report on commissioning, identifying any deficiencies that remain outstanding;
 - .2 recommend any training and/or instructions to be given to Owner's operating and maintenance personnel in addition to training and instructions already given;
 - .3 after Substantial Performance of the Work, witness system checks and validate documentation by Contractor as follows:
 - .1 once during first month of building operation;
 - .2 once during third month of building operation;
 - .3 once between fourth and tenth month of building operation but during a season opposite to first or third month visits.
 - .4 ensure any deficient work resulting from system checks described above are corrected;
 - .5 3 months after Substantial Performance of the Work, attend a question and answer session(s) with Contractor to answer any questions and concerns related to commissioning work from Owner's operating personnel.

END OF SECTION

- 1 General
- 1.1 **SUBMITTALS**
 - .1 Submit shop drawings for products specified in this Section.
- 1.2 **PRODUCT COMPATIBILITY**
 - .1 Lighting controls and luminaires when integrated together for control purposes must be 100% compatible with each other. Coordinate with ballast/driver and lamp manufacturers, LV relay panel manufacturers and dimmer/occupancy control manufacturers to ensure that components are compatible with each other and that interconnections do not affect performance, life or any warranties.
 - .2 These products shall be coordinated with switching devices in Section 26 27 26 which must be in the same line up and have similar appearances.
- 2 Products
- 1.1 **SWITCHES**
 - .1 Switches to be CSA approved, ULC listed and labelled devices.
 - .2 Hubbell Canada Inc., HBL 1221 Series, CSA approved, heavy duty, industrial grade, back, and side wired, AC quiet action toggle type, 20 ampere, 120-277 V switches. Switches to include steel-nickel plated bridge, nylon toggle, one piece rivetless copper alloy spring contact arm and terminal plate, silver cadmium oxide contacts, brass binding head screws, one piece integral grounding terminal and stainless steel automatic grounding clips. Provide single way, 2-way, 3-way, and key type to suit specific application requirements.
 - .3 Hubbell Canada Inc., DS120 "Style Line" decorator series, CSA approved, specification grade, back and side wired, A.C. rocker type, 20 ampere, 120-277 V switches. Switches to include steel-nickel plated bridge, nylon rocker, one piece rivetless copper alloy spring contact arm and terminal plate, silver cadmium oxide contacts, brass binding head screws, one piece integral grounding terminal and stainless steel automatic grounding clips. Provide single way, 2-way, 3-way, and pilot type to suit specific application requirements.
 - .4 Acceptable manufacturers are;
 - .1 Legrand-Watt Stopper;
 - .2 Hubbell;
 - .3 Acuity Brands;
 - .4 Leviton;
 - .5 Lutron;
 - .6 GE Lighting.

3 Execution

1.1 **INSTALLATION OF SWITCHES**

- .1 Provide switches and install in electrical outlet boxes. Refer to drawings to determine flush or surface mounting requirements. Generally, flush mount devices in finished areas. Size electrical boxes to suit device requirements as per device manufacturer's recommendations. Properly ground device to box and ground system as per code requirements and manufacturer's instructions.
- .2 For pricing only, switches to be ivory for devices connected to normal power circuits, red for devices connected to essential power circuits.
- .3 Ensure that switches located adjacent to doors are located at strike side of door. Confirm door swing requirements on architectural drawings, not on electrical drawings.
- .4 Confirm final switch finishes with Consultant as per sample board submission specified in Part 1. Do not order any devices unless final finishes have been approved by Consultant.
- .5 Additionally, refer to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

END OF SECTION

1 General

1.1 **SUBMITTALS**

- .1 Submit shop drawings for products specified in this Section.
- .2 Submit samples of each typical wiring device, faceplates, finishes and colours. Mount to sample board, clearly labelling devices and finishes. Submit for review by Owner and Consultant. Do not order any device unless finishes have been reviewed and approved by Consultant.

2 Products

1.1 **SWITCHES**

- .1 Switches to be CSA approved, ULC listed and labelled devices.
- .2 Hubbell Canada Inc., HBL 1221 Series, CSA approved, heavy duty, industrial grade, back, and side wired, AC quiet action toggle type, 20 ampere, 120-277 V switches. Switches to include steel-nickel plated bridge, nylon toggle, one piece rivetless copper alloy spring contact arm and terminal plate, silver cadmium oxide contacts, brass binding head screws, one piece integral grounding terminal and stainless steel automatic grounding clips. Provide single way, 2-way, 3-way, and key type to suit specific application requirements.
- .3 Acceptable manufacturers are:
 - .1 Hubbell Canada Inc.;
 - .2 Cooper Wiring Devices (Arrow Hart);
 - .3 Legrand - Pass & Seymour;
 - .4 Leviton.

1.2 **RECEPTACLES**

- .1 Receptacles to be CSA approved, ULC listed, certified and labelled devices.
- .2 Hubbell Canada Inc., No. HBL5262 / HBL5362 CSA approved, ULC listed, extra heavy duty, specification grade, back and side wired, flush, nylon face/body construction, duplex U-ground, 15/20 ampere, 125 V, 2-pole, 3-wire grounding receptacles complete with one piece nickel-plated brass mounting strip with integral grounding clips, ground retention clips, nickel-plated brass wiring clamps with nickel-plated brass screws, front circuit identification area and reinforced thermoplastic base.
- .3 Hubbell Canada Inc., No. HBL 5361 series, extra heavy duty, specification grade, flush, nylon face, single, 20 ampere, 125 V, 3-wire grounding receptacles.
- .4 Hubbell Canada Inc., No. HBL 5461 series, extra heavy duty, specification grade, flush, nylon face, single, 20 ampere, 250 V, 2-pole 3-wire grounding receptacle.
- .5 Hubbell Canada, No. HBL5262SA / HBL5362SA "CIRCUITGUARD" Series, specification grade, 15/20 ampere, 125 V, duplex, surge suppression receptacles in blue finish, complete with light and alarm, 240 joules/15000A per mode.

- .6 Hubbell Canada, No. IG5262SA / IG5362SA "CIRCUITGUARD" Series, specification grade, 15/20 ampere, 125 V, duplex, isolated ground, surge suppression receptacles in blue finish, complete with light and alarm, 240 joules/15000A per mode.
- .7 Hubbell Canada Inc., No. BR15TR series, commercial specification grade, 15 ampere, 125 V, 2-pole, 3-wire grounding, tamper-resistant (safety shutter) duplex receptacles.
- .8 Hubbell Canada, No. GFR 5262TR / GFR 5362TR "CIRCUIT GUARD" Series, extra heavy duty grade, 15/20 ampere, 125 V, duplex, ULC Class "A", Group One, tamper resistant, weather resistant ground fault circuit interrupting receptacles complete with red ground fault LED and 10ka short circuit current rating.
- .9 Hubbell Canada Inc., No. USB 15AC "Style Line" series, CSA approved, ULC listed, tamper resistant, back and side wired, 15 ampere, 125 V
- .10 Where noted that 20 A receptacles are required, include for "T" slot type of respective series of receptacles.
- .11 Colour of special switches and receptacles (unless specified above), to be as specified in PART 3 of this Section of Specification.
- .12 Special switches and receptacles not specified above are to be specified on drawings. Low voltage lighting controls are specified in Section entitled Lighting Control.
- .13 Acceptable manufacturers are:
 - .1 Hubbell Canada Inc.;
 - .2 Cooper Wiring Devices (Arrow Hart);
 - .3 Legrand - Pass & Seymour;
 - .4 Leviton.

1.3 **FACEPLATES**

- .1 Grade 18 8, type 430, 1 mm (0.032") thick stainless steel, satin, brushed or natural finish, complete with a peel off protective plastic film, and stainless steel screws.
- .2 Hubbell Canada Inc., No. WP8E / WP8EH, NEMA 3R rated, CSA approved, ULC listed and labelled, single gang, vertical/horizontal mounting, weather-proof in-use, gasketted, cast aluminium faceplates for standard duplex receptacles in wet locations.
- .3 Hubbell Canada Inc., No. WP26E/WP26EH, NEMA 3R rated, CSA approved, ULC listed and labelled, single gang, vertical/horizontal mounting, weather-proof in-use, gasketted, cast aluminium faceplates for GFI receptacles in wet locations.
- .4 Hubbell Canada Inc., No. HBL1795, ULC listed and labelled, single gang, vertical mounting, weather proof in-use, gasketted, clear bubble plate, silicone rubber faceplates for standard AC toggle switches in wet locations.
- .5 Galvanized steel stamped faceplates.
- .6 Colours and finishes of faceplates are specified in Part 3 of this Section.
- .7 Acceptable manufacturers are as per switches and receptacles.

1.4 **PUSHBUTTONS OPERATORS**

- .1 Rockwell Automation (Allen-Bradley) Ltd., 800T Series operators as follows:
 - .1 emergency off pushbuttons: oversized 60 mm (2-1/2") diameter red plastic mushroom head pushbutton with shroud, thrust washer, and an aluminum faceplate with "EMERGENCY POWER OFF" identification lettering or other nomenclature as required to suit application;
 - .2 pushbuttons: standard 30 mm (1-1/4") diameter plastic pushbuttons in Red/Green colours as required for application, momentary/maintained/2 position push-pull operations as required, flush/extended/mushroom heads; non-illuminated/illuminated, with aluminum faceplate with identification lettering nomenclature as required to suit application;
 - .3 selector switches: 30 mm (1-1/4") diameter standard knob selector switches, 2/3 position maintained contact operations; non-illuminated, with aluminum faceplate with identification lettering nomenclature as required to suit application;
 - .4 key operated switches: standard 30 mm (1-1/4") diameter key cylinder lock operator, 2 or 3 position operations; non-illuminated, with aluminum faceplate with identification lettering nomenclature as required to suit application;
 - .5 pilot lamps: 30 mm (1-1/4") diameter illuminated LED pilot lights, red/green/amber/white/clear colours as required to suit application; of voltage ratings as required to suit application; with contact block; with aluminum faceplate with identification lettering nomenclature as required to suit application; push to test feature where required;
 - .6 with enamel painted steel or stainless steel faceplate for flush mounting onto recessed wall boxes or in millwork, suitable for mounting of devices;
 - .7 with NEMA 1 box for surface mounting applications in climate controlled areas, CSA approved for application and of size suitable for mounting of devices;
 - .8 with minimum NEMA 3R box for surface mounting applications in non-climate controlled areas, CSA approved for application and of size suitable for mounting of devices;
 - .9 with STI type flip open polycarbonate tamper-proof cover and audible alarm device activated when cover is open, and custom labelling.
- .2 Exact type and ratings of devices are to suit specific applications.
- .3 Acceptable manufacturers:
 - .1 Rockwell Automation (Allen-Bradley);
 - .2 Eaton (Cutler-Hammer);
 - .3 Square D;
 - .4 GE.

3 Execution

1.1 INSTALLATION OF SWITCHES

- .1 Provide switches and install in electrical outlet boxes. Refer to drawings to determine flush or surface mounting requirements. Generally, flush mount devices in finished areas. Size electrical boxes to suit device requirements as per device manufacturer's recommendations. Properly ground device to box and ground system as per code requirements and manufacturer's instructions.
- .2 For pricing only, switches to be ivory for devices connected to normal power circuits, red for devices connected to emergency power circuits.
- .3 Ensure that switches located adjacent to doors are located at strike side of door. Confirm door swing requirements on architectural drawings, not on electrical drawings.
- .4 Confirm final switch finishes with Consultant as per sample board submission specified in Part 1. Do not order any devices unless final finishes have been approved by Consultant.
- .5 Additionally, refer to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

1.2 INSTALLATION OF RECEPTACLES

- .1 Provide receptacles and install in electrical outlet boxes. Refer to drawings to determine flush or surface mounting requirements. Generally, flush mount devices in finished areas. Size electrical boxes to suit device requirements as per device manufacturer's recommendations. Properly ground device to box and ground system as per code requirements and manufacturer's instructions.
- .2 For pricing only, receptacles to be ivory for devices connected to normal power circuits, red for devices connected to emergency power circuits.
- .3 Install USB charger receptacles in extra deep boxes in accordance with manufacturer's recommendations.
- .4 Install exterior receptacles located in landscaped grounds in accordance with drawing detail.
- .5 Confirm receptacle finishes via submission of sample board to Consultant. Do not order any devices unless final finishes have been approved by Consultant.
- .6 Where receptacles are indicated in counters and benches, box cut-out to be provided in counter and bench. Provide a box, receptacle, plate and branch circuit wiring. Branch circuit wiring within counters and benches to be flexible armoured cable, under requirements of local governing electrical code and standards. Install and connect complete.
- .7 Confirm final receptacle finishes with Consultant as per sample board submission specified in Part 1. Do not order any devices unless final finishes have been approved by Consultant.
- .8 Additionally, refer to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

1.3 INSTALLATION OF FACEPLATES

- .1 Provide each switch and receptacle with a faceplate with an opening or openings suitable for device it conceals and covers openings around boxes. Secure faceplates to device frames with screws to match faceplates. Provide larger than standard type faceplates for devices that require engraved nomenclature to define special purpose for that device.
- .2 Provide nylon type faceplates for switches and receptacles circuited to emergency power sources. For flush mounted devices, provide oversized faceplates as required to properly cover wall openings around recessed boxes. Provide faceplates with suitable identification label. Colour finish to be red, but to be confirmed with Consultant.
- .3 Provide galvanized stamped steel faceplates in service areas and equipment rooms where devices are surface mounted.
- .4 Provide faceplates for housekeeping receptacles with label printed with "Housekeeping Only" lettering.
- .5 Provide weatherproof insulated faceplates with hinged and gasketted receptacle access flaps for weatherproof receptacles denoted "WP" on drawings.
- .6 Generally, oversized faceplates to be provided where engraved lettering is required.
- .7 Faceplates for flush floor mounted receptacles to be forged brass rectangular faceplates.
- .8 Confirm exact material, finish, and colour of faceplates for devices in any particular area with Consultant prior to ordering. Submit sample board as per requirements of Part 1.
- .9 Provide faceplates with printed self-adhesive label on inside face identifying circuit number and panel feeding device. Turn over label maker to Consultant prior to application for Certificate of Substantial Performance of the Work.

1.4 INSTALLATION OF PUSHBUTTON OPERATORS

- .1 Provide specified and suitable pushbutton operators and pilot lamps to suit various applications.
- .2 Where flush mounted, provide faceplate for mounting onto recessed boxes.
- .3 Where surface mounted climate controlled areas, provide suitable NEMA 1 box. In non-climate controlled areas, surface mounted devices to be mounted within minimum NEMA 3R rated boxes.
- .4 Install devices in accordance with manufacturer's instructions to suit application requirements of Owner. Connect complete to respective equipment being controlled. Provide required wiring in conduit.
- .5 Test and verify operation of each device. Provide engraved lamaroid nameplate to identify system being operated and any special instructions. Confirm exact nomenclature with Consultant prior to ordering.

END OF SECTION

1 General

1.1 **SUBMITTALS**

- .1 Submit shop drawings for products specified in this Section.

2 Products

2.1 **DISCONNECT SWITCHES**

- .1 Eaton (Cutler-Hammer), heavy duty, CSA approved, disconnect (safety) switches. Features include:
- .1 front operated with a handle suitable for padlocking in "OFF" position and arranged so that enclosure cover cannot be opened while handle is in "ON" position;
 - .2 operating mechanisms: quick-break, positive acting with visible blades and a line terminal shield;
 - .3 fusible units with fuse clips suitable for HRC fuses, unless otherwise noted;
 - .4 ampere rating, number of poles and fuse requirements as indicated on drawings;
 - .5 factory primed and painted switch enclosures.
- .2 Disconnects for variable speed drives to be suitable for use with such drives and include auxiliary switch/contact to de-energize control power circuit, as required and as applicable.
- .3 Enclosures for disconnects mounted in interior climate controlled areas and standard non-climate controlled areas to be NEMA 3R . For corrosive environmental applications, enclosures to be minimum NEMA 4X.
- .4 Acceptable manufacturers are:
- .1 Eaton (Cutler-Hammer);
 - .2 Siemens Electric Ltd.;
 - .3 Schneider Electric (Square D).

2.2 **FUSES**

- .1 Unless otherwise indicated, fuses to be Form I, Class "J" HRC fuses for constantly running equipment, and Form II, Class "C" HRC fuses for motorized equipment that cycle "ON" and "OFF".
- .2 Fuses to be of type suitable for applications as required by local governing electrical codes and in coordination with respective equipment manufacturer's recommendations in which fuses are required. Coordinate also with Mechanical Division Contractor for requirements for Mechanical Division equipment.
- .3 Fuses to be of product of one manufacturer.
- .4 Acceptable manufacturers are:
- .1 Mersen (Ferraz Shawmut);
 - .2 English Electric Ltd.;
 - .3 Noram;
 - .4 Cooper Bussmann.

2.3 **ENCLOSED CIRCUIT BREAKERS**

- .1 Eaton (Cutler-Hammer), moulded case, front operated, surface mounted, automatic circuit breakers sized on drawings, each secured in NEMA 3R wall mounting enclosure with steel front panel and arranged so that circuit breaker can be padlocked in OFF position. Cover interlocked such that cover cannot be opened if breaker is in ON position.
- .2 Eaton (Cutler-Hammer), moulded case, front operated, flush mounted, automatic circuit breakers sized on drawings, each secured in NEMA 1 wall mounting enclosure with steel front panel and arranged so that circuit breaker can be padlocked in OFF position. Cover interlocked such that cover cannot be opened if breaker is in ON position.
- .3 Acceptable manufacturers are:
 - .1 Eaton (Cutler-Hammer);
 - .2 Schneider Electric (Square D);
 - .3 Siemens Electric Ltd.

3 Execution

3.1 **INSTALLATION OF DISCONNECT SWITCHES**

- .1 Provide disconnects switches and install into locations and connect complete. Ensure adequate clearance is provided as per local code requirements and as required for access for operation and maintenance. Install as follows:
 - .1 wherever shown on drawings and/or specified herein;
 - .2 wherever required by MCC/VFD/starter schedule drawings;
 - .3 for motorized equipment which cannot be seen from motor starter location or is more than 9 m (30') from starter location (in accordance with local governing electrical code requirements);
 - .4 for "packaged" equipment fed from a motor starter panel.
- .2 Ensure enclosure ratings are suitable for intended applications.
- .3 Provide engraved Lamacoid nameplate with nomenclature reviewed with Consultant.

3.2 **INSTALLATION OF FUSES**

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Ensure correct fuses fitted to physically matched mounting devices.
- .3 Ensure correct fuses fitted to assigned electrical circuit.
- .4 Provide a complete set of fuses for each fusible disconnect, motor starter, and similar fusible equipment provided or supplied.
- .5 Supply 3 spare fuses of each size and type used on project, mount fuses in cabinet. Secure cabinet in wall location as reviewed with Consultant.

3.3 **INSTALLATION OF ENCLOSED CIRCUIT BREAKERS**

- .1 Provide wall mounted enclosed, circuit breakers for equipment. Include required accessories. Secure to wall construction and connect complete.
- .2 Confirm exact locations prior to roughing-in.

- .3 Ground and bond equipment as per local governing electrical code and inspection authority requirements. Refer also to requirements of grounding and bonding article.
- .4 Provide a lamacoid identification nameplate for each enclosure. Confirm exact nomenclature with Consultant prior to manufacturer.
- .5 Additionally, refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

END OF SECTION

1 General

1.1 **SUBMITTALS**

- .1 Submit shop drawings for products of this Section, and on Schedule of Luminaires on drawings.
- .2 Include photometric data, lamp, and ballast information for each luminaire. Include ballast data identifying maximum circuit loading limitations.
- .3 Photometric data to include: total input watts, candlepower summary, candela distribution zonal lumen summary, luminaire efficiency, CIE type, coefficient of utilization, lamp type and lumen rating in accordance with IESNA testing procedures.
- .4 Include copy of certification that lenses and louvers comply with local governing building code requirements for flame spread ratings.
- .5 For poles, submit documentation that poles supplied are suitable for steady wind velocity and gust velocity of area of installation, and suitable for total effective projected area of mounted lighting equipment.
- .6 For exterior site areas or parking areas, where luminaires are proposed that are not from based specified manufacturer, provide luminaire manufacturer's computer prepared detailed photometric layout drawings with complete photometry showing performance levels of proposed luminaires. Clearly identify lighting levels, quantity, locations, mounting heights, etc. Identify variances from base design.

1.2 **WARRANTY**

- .1 Warranty requirements are as follows:
 - .1 unless otherwise noted, LED and LED drivers for a period of five (5) years from date of acceptance of Work by Owner for its intended use;
 - .2 unless otherwise noted, solid state ballasts for a period of five (5) years from date of acceptance of Work by Owner for its intended use;
 - .3 include costs for personnel, equipment and labour for replacing lamps and ballasts covered under warranty;

1.3 **SPARE LAMPS**

- .1 In addition to including lamps except for LED types for each luminaire, provide spare lamps and turn over to Owner based on following criteria:
 - .1 one (1) spare lamp for each type of luminaire used for site lighting;
 - .2 a quantity of ten percent (10%) of each type of lamp used for luminaires on this project rounded up to manufacturer's standard whole case if quantity is less than a case;
 - .3 each type to be provided in separate identified containers.

1.4 **SUBSTITUTIONS**

- .1 Provide luminaires as specified in Schedule of Luminaires and as per documented List of Manufacturers, where applicable. During construction period, no substitutions are permitted unless compelling reasons are given and accepted by Owner and Consultant. A delay caused by Contractor's failure to order luminaires to meet construction schedule is not a valid reason.
- .2 Make requests for proposed substitutions as per requirements of Section entitled Electrical Work General Instructions and Division 01.
- .3 Consideration of any proposed substitutions after Bid Period to be at Consultant's sole discretion.

2 Products

2.1 **LUMINAIRES**

- .1 Provide luminaires in accordance with Schedule of Luminaires found on drawings. Luminaires are to be CSA approved or have special local electrical authority approval.
- .2 Provide thickness of metal as indicated in Schedule of Luminaires and details, or as required so that luminaires are rigid, stable and resists deflection, twisting, warping or bending under normal installation procedures, re-lamping etc., or no less than requirements specified herein the specifications.
- .3 Unless otherwise noted, linear and continuous linear architectural LED luminaires bodies to be constructed of extruded aluminum and of rigid construction. Unless otherwise noted, provide body finishes of corrosion resistant, chemically treated and electrostatically applied post powder coat finish. Efficiency not to be less than 69%.
- .4 Unless otherwise noted, vandal resistant luminaires to be constructed of heavy duty extruded aluminum rails and die cast end caps, complete with stainless steel torx with centre reject pin and Allen head set screws. Screw heads to be mounted and concealed under lens. Lens to be extruded UV stabilized polycarbonate lens with internal linear ribbed design.
- .5 Provide neoprene or silicone gasketting, barriers and stops where required to prevent light leaks or water/water vapour penetration.
- .6 Fabricate housings to allow for easy accessibility and replacement of parts.
- .7 Fabricate fixtures with a minimum number of joints. Make unexposed joints by acceptable method such as welding, brazing, screwing or bolting. Soldered joints are unacceptable. Do not use blind metal tapping methods or rivets for fastening parts which must be removed during service, or for fastening electrical components and supports. Cast parts, including die-cast members, to be of uniform quality, close grained, rigid, true to pattern, free from blow holes, pores, discoloration, hard spots, shrinkage defects, and cracks or other imperfections that affect strength and appearance or are indicative of inferior metals or alloys.
- .8 Reflectors and reflecting cones or baffles to be free of any tooling marks, spinning lines or marks by other assembly techniques. Finishes to be equal to first quality polished, baffled, and anodized "Alzak".
- .9 Lamp sockets to be suitable for indicated lamps and be set so that lamps are positioned in optically correct relation to all luminaire components. Preset adjustable sockets at factory for lamp specified.

- .10 Lenses and louvres to comply with local governing building code and other local governing code flame spread rating requirements.
- .11 Unless otherwise noted, construct acrylic lens from 100% virgin acrylic and not less than 3.22 mm (0.125") thick. Glass lenses to be minimum 9.5 mm (0.375") thick.
- .12 Recessed luminaires with replaceable/serviceable parts such as ballasts, lamps, sockets, etc., must be accessible from lens side (ie. room side) of fixtures to allow for proper accessibility.
- .13 Luminaires to be factory assembled and tested prior to delivery on site.
- .14 Exposed parts and hardware of luminaires located in non-climate controlled areas to be corrosion resistant and weather resistant. Hardware to be tamper-proof. Manufacturer exterior luminaire poles with corrosion resistant finish and construction. Pole suppliers to ensure that poles supplied are suitable for steady wind velocity and gust velocity of area of installation, and suitable for total effective projected area of lighting equipment. Submit verification of this with shop drawings.
- .15 When requested, submit luminaire samples.
- .16 Dimensions for coves, valances, and strips as shown on drawings are for bidding purposes only. Job measure for exact dimensions of louvres, lenses and strips.
- .17 Dimensions for linear and continuous linear LED as shown on drawings are for bidding purposes only. Job measure for exact dimensions requirements to suit installation location.
- .18 Confirm exact colours and finishes of luminaires with Consultant after award of contract but prior to ordering. Obtain information in time to meet installation schedule.
- .19 Coordinate with ballast manufacturers and dimmer/occupancy control manufacturers to ensure that components are compatible with each other and that interconnections do not affect performance, life or any warranties.
- .20 Products of same specified type to be of same manufacturer.

1.2 **LEDs AND DRIVERS**

- .1 General features include:
 - .1 CSA approved, ULC listed and labelled;
 - .2 Operating temperature:
 - .1 Luminaires for applications in non-climate controlled area: operating temperature range through -40°C (-40°F) to 60°C (140°F);
 - .2 Luminaires for applications in climate controlled area: operating temperature range through -20°C (-4°F) to 50°C (122°F);
 - .3 With rapid and changing development of LED technology, provide most technically proven and most advanced and successfully tested LED technology at time of installation;
 - .4 Specification standards to meet requirements of IES LM 79 and LM-80.
 - .5 Be 100% compatible with connected dimmer controls to provide dimming down to 5%.
- .2 Light emitting diodes (LEDs) features to include:
 - .1 LEDs to be selected from same colour bin size for consistency in chromaticity and meet ANSI C78 377A as a minimum;

- .2 generally, colour temperature range to be from 2700 K to 6500 K; specific temperature requirements to be identified on Schedule of Luminaires;
- .3 minimum CRI of 80 ;
- .4 rated life (based on 70% lumen depreciation level) from 50,000 to 70,000 hours.
- .3 Driver (ballast) features to include:
 - .1 Operate from 60 Hz input source of 120 VAC with sustained variations of $\pm 10\%$ (voltage and frequency) with no damage to driver;
 - .2 Output regulated to $\pm 5\%$ across load range;
 - .3 Power factor greater than 0.90;
 - .4 Total harmonic distortion less than 20%;
 - .5 Class A sound rating;
 - .6 Comply with ANSI C62.41 Category A for transient protection.
- .4 Acceptable manufacturers to be as recommended by luminaire manufacturers.

3 Execution

3.1 **INSTALLATION**

- .1 Provide luminaires as required. Obtain required training from manufacturer's representative on any special installation procedures. Install products in accordance with manufacturer's instructions to suit specific installation requirements.
- .2 Before placing luminaire orders:
 - .1 verify quantity requirements;
 - .2 thoroughly review ceiling types, finishes and construction details; verify ceiling types with latest Architectural Drawings; order luminaires to suit correct ceiling type;
 - .3 ensure that required mounting assemblies, frames, rings and similar features are included;
 - .4 confirm colours and finishes with Consultant.
- .3 Include for assembly and mounting of luminaires and lamps, complete with:
 - .1 wiring and connections;
 - .2 fittings and hangers;
 - .3 aligners;
 - .4 box covers;
 - .5 other accessories required for a complete, safe and fully operational assembly.
- .4 Where outlet boxes locations are shown on drawings, they are diagrammatic only. Position outlet boxes to coincide with suspension hangers and knockouts.
- .5 Install ceiling fixtures in centre of tiles unless dimensioned otherwise on Reflected Ceiling Plans. Locate hangers on tile centres or intersections. Mount recessed downlights, troffers, and surface mounted luminaires in or on full tiles. Install fixtures in and on acoustical tile ceilings in alignment with tile joints.

- .6 Cut holes for recessed luminaires to exact size so that gaps are not visible or luminaire trims cover gaps.
- .7 Mount surface ceiling luminaires perfectly level or plumb, tightly to ceiling without showing a space or light leak between frame and ceiling.
- .8 Carefully align linear luminaires shown in continuous lines or rows, so that rows appear as straight lines. Variation in alignment not to exceed 6 mm (1/4") for any 5 m (16') run.
- .9 Provide spacers for fixtures mounted on low density ceiling material.
- .10 Provide plaster frames for recessed fixtures in plaster or gypsum board ceilings.
- .11 Prepare fixtures, trim and poles and standards required to be painted.
- .12 Protect wiring with tape or tubing at all points where abrasion may occur. Conceal wiring within fixture construction except where design or mounting dictates otherwise.
- .13 Splices:
 - .1 Minimize number of splices.
 - .2 Make with approved mechanical insulated steel spring type connectors, suitable for temperature and voltage conditions to which splices are to be subjected.
 - .3 Splices are not to be made unless properly terminated in accessible identified junction boxes.
- .14 Support luminaires directly by ceiling slab structure and not to formed steel decking, ceiling hangers, ductwork, piping, cable trays, etc.
- .15 Do not tighten wing nuts, bolts, or screws that allow fixture adjustment for recessed adjustable fixtures.
- .16 Install spread lenses only where called out on Schedule of Luminaires and Specifications.
- .17 Use cloth gloves when handling reflector cones, louvers, halogen lamps, glass, sconces and all exposed surfaces of fixtures.
- .18 Co-ordinate luminaire installation with work of other trades to ensure that necessary recessing depths and mounting spaces are provided.
- .19 Install luminaires in accordance with applicable architectural drawing reflected ceiling plans and/or wall elevations and/or field instructions issued by Consultant. Confirm luminaire locations prior to roughing-in. In equipment rooms, shafts and similar secondary areas, install luminaires after mechanical and other major work is roughed in and adjust luminaire locations as required.
- .20 Align and position all adjustable luminaires, and ensure that luminaires with adjustable lamp holders are properly positioned to correspond to lamps specified.
- .21 Comply with requirements of local governing electrical code regarding support of luminaires in suspended ceilings.
- .22 Independently suspend luminaires in suspended ceilings from ceiling slab. For each luminaire, provide minimum two (2) cable supports secured to ceiling slab and to luminaire. Confirm with local governing authorities and review with Consultant if a variance to this requirement can be made for specific luminaires of low weight.
- .23 Connect luminaires to power circuits and controls as required. Refer to drawings notes and schedules. Include for both normal and emergency power circuits as required.

- .24 Locate exit signs in final locations confirmed with Consultant and approved by local building code authority. Connect to power circuits as required. Where applicable for emergency power requirements, connect to emergency battery units. Relocate exit sign and re-direct direction arrows to suit local building code authority requirements and Consultant's directions.
- .25 Notify Consultant immediately and relocate if necessary as directed by Consultant, if:
 - .1 fixture placement is in conflict with a structural beam, mechanical duct, plumbing pipe, etc.;
 - .2 space above ceiling is not sufficient;
 - .3 any reason that a fixture cannot be located where it is dimensioned or shown on construction documents.
- .26 Concrete Bases:
 - .1 Secure poles for pole mounted, exterior type luminaires to concrete bases as detailed.
 - .2 Co-ordinate required work including excavation/backfilling/concrete work to provide bases as shown.
 - .3 Provide anchor bolt covers and anchor bolt templates for proper positioning of anchor bolts in concrete.
 - .4 Refer to concrete base detail found on drawings; this detail is for general requirements only.
 - .5 Include costs for and engage Professional Structural Engineer licensed in Place of Work and with liability insurance, to review and endorse final base design work; review exact details with Consultant; grade levels may be different in various areas.
- .27 Extend ground conductors from metal parts of poles to building grounding provisions. Generally locate devices in locations on drawings, but base exact locations on coordination and review with Consultant and governing authorities. Confirm luminaires and pole finishes with Consultant prior to ordering. Run wiring in conduit.
- .28 Provide seismic restraints to suspended luminaires, in accordance with latest local governing building code requirements.
- .29 Provide dimming ballasts in luminaires to be dimmed. Coordinate between dimming system vendor and luminaire vendors to ensure 100% compatibility.
- .30 Ground and bond luminaires as per local governing electrical code requirements.
- .31 If requested, demonstrate operation of luminaires intended for special applications such as building floodlights and other decorative purposes. Adjust their locations within a reasonable distance to obtain effects desired.
- .32 Test and adjust exterior luminaires at times after sunset, in presence of Consultant and at times acceptable to Consultant.
- .33 Prior to turn over of Work to Owner, clean luminaires in manner recommended by manufacturer and to satisfaction of Consultant.
- .34 Additionally, refer to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

END OF SECTION

PART 1 – GENERAL

1.1 References

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- .2 Division 25 Specification Sections apply to this Section.
- .3 Division 26 Specification Sections apply to this Section.
- .4 Division 27 Specification Sections apply to this Section.
- .5 Division 28 Specification Sections apply to this Section.
- .6 This section specifies products, criteria and characteristics, and methods and execution that are common to one of more Mechanical and Electrical Sections. It is intended to supplement to each Electrical and Communications Section and is to be read accordingly.

1.2 Submittals

- .1 Submit shop drawings for products specified in this Section.

1.3 Work Included in the Low Voltage Communications Contract

- .1 The mention of an article, operation or method requires that the extra-low voltage communications systems Contractor (Contractor) shall provide same and perform each operation in accordance with the conditions stated. The Contractor shall provide material, labour, equipment, and transportation to complete the project in compliance with the contract documents to provide a complete and fully functional installed system.
- .2 Work shall be installed in accordance with local inspection authorities having jurisdiction together with the recommendations of the manufacturer whose equipment is to be supplied and installed under this Contract.
- .3 Drawings and specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Although work is not specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices, and materials obviously necessary for a sound, secure and complete installation.
- .4 Provide all services and coordination representing the Owner for all incoming services voice and data and TV.
- .5 It is the intent that these specifications and drawings are to establish minimum requirements for methods, products, and equipment and to provide electrical service, distribution and systems finished, tested and ready for operation. Incidental detail not usually shown or specified, but necessary for proper installation and operation shall be included in the work and the Contractor's estimate, the same as if specified.
- .6 Locations of all equipment and material shall be adjusted at no extra cost to the Owner, to accommodate the work interferences anticipated and/or encountered.

- .7 Prior to installation, determine the exact route and location of each raceway and piece of equipment to minimize conflicts with other trades.
- .8 The Contractor, in conjunction with the Consultant and Owner's representative, shall establish exact locations of materials and equipment to be installed. Consideration shall be given to construction features, equipment of other trades and requirements of the equipment proper.
- .9 Give notices, file plans, obtain permits and licenses, pay fees and back charges, and obtain necessary approvals from authorities that have jurisdiction as required to perform work in accordance with all legal requirements and with Specifications, Drawings, Addenda and Change Orders, all of which are part of Contract Documents.
- .10 Before submitting a bid, each bidder shall examine the drawings relating to their work and shall become informed as to the extent and character of the work required and its relation to other work in the building.
- .11 This project may be phased, as defined by the Owner and Architect. This may necessitate the provision of temporary cabling and connectivity to maintain newly constructed and existing areas of the project that may be affected by the phasing of construction. Contractor shall be responsible for providing, installing, and removing all temporary cabling and connectivity as required in their original bid. All associated appurtenances with the utilities shall be provided as part of this project.
- .12 Materials shall be suitably stored and protected prior to installation and work shall be protected after installation, during construction and prior to acceptance.
- .13 The Contractor shall furnish scaffolding, rigging, hoisting and services necessary for delivery, erection and installation of equipment and apparatus required to be installed by the Contractor. This equipment shall be removed by the Contractor upon completion of the project.

1.4 Permits and Licenses

- .1 The Contractor shall prepare and submit applications and working drawings to authorities having jurisdiction over the project. Licenses and permits required shall be secured and paid for by the Contractor.

1.5 Standards and Codes

- .1 Work shall be installed in accordance with National, Provincial, and Local codes, ordinances, laws, and regulations. Comply with applicable OSHA regulations.
- .2 Work shall be installed in accordance with BICSI, IEEE, ANSI, and TIA/EIA standards latest versions.
- .3 Materials shall have a UL or ETL label where a UL or ETL Standard or test exists.
- .4 International, national, and local codes and standards:
 - .1 National Building Code (NBC)
 - .2 National Fire Code (NFC)
 - .3 National Energy Code of Canada for Buildings (NECB)

- .4 CSA C22.1 Canadian Electric Code, Part 1
- .5 CSA C22.2 No. 214 Communications Cables CSA C22.2 No. 232-M Fibre Optic Cables FCC Rules 47 CFR 0-19 Telecommunications
- .6 ASTM E2085-00a Standard Guide on Security Framework for Healthcare Information
- .7 ASTM E1869-04 Standard Guide for Confidentiality, Privacy, Access, and Data Security Principles for Health Information Including Electronic Health Records
- .8 Electrical Safety Authority
- .9 CENELEC EN 50173 Information Technology: Generic Cabling Systems
- .10 FIPS PUB 174 Commercial Building Telecommunications Wiring Standard
- .11 IEC 603-7, PART 7 Detail Specification for Connectors, 8-Way, Including Fixed and Free Connectors with Common Mating Features
- .12 IEC 807-8 Rectangular Connectors for Frequencies Below 3 MHz, Part 8: Detailed Specification for Connectors, Four-Signal Contacts and Earthing Contacts for Cable Screens, First Edition
- .13 ISO/IEC IS 11801A Generic Cabling for Customer Premises
- .14 NEMA WC 63 Performance Standard for Field Testing of Unshielded Twisted-Pair Cabling System
- .15 ULC-S317-1996, Installation and Classification of Closed-Circuit Video Equipment (CCVC) Systems for Institutional and Commercial Integrated Security Management Systems.
- .16 UL 444 and 13 Adopted Test and Follow-Up Service Requirements for the Optional Qualification of 100ohm; Twisted-Pair
- .17 UL 60950 Standard for Safety of Information Technology Equipment
- .18 UL 969, Standard for Marking and Labelling Systems
- .19 CIP-002-3 through CIP-009-3 – Critical Infrastructure Protection
- .20 Public Hospitals Act
- .21 Personal Health Information Protection Act
- .22 Personal Information Protection and Electronic Documents Act
- .23 CSA standard Z318.0, Commissioning of Health Care Facilities
- .24 Local Building Department
- .25 Local Fire Department
- .26 Other Municipality Bylaws
- .5 American Society for Industrial Security (ASIS)
 - .1 ASIS/SHRM WVP.1-2011 Workplace Violence Prevention and Intervention ANSI Standard
 - .2 ANSI/ASIS/RIMS RA.1-2015 Risk Assessment

- .3 ANSI/ASIS PAP.1-2012 Security Management Standard: Physical Asset Protection
- .4 ANSI/ASIS CSO.1-2013 Chief Security Officer (CSO) Organizational Model
- .5 ASIS FPSM GDL (2009) Facilities Physical Security Measures Guideline
- .6 Telecommunication Industry Association (TIA)
 - .1 ANSI/EIA/TIA 568.0-E Generic Telecommunications Cabling for Customer Premises
 - .2 ANSI/EIA/TIA 568.1-E Commercial Building Telecommunications Infrastructure Standard
 - .3 ANSI/EIA/TIA 568.2-E Balanced Twisted-pair Telecommunications Cabling and Components Standards
 - .4 ANSI/EIA/TIA 568.3-E Optical Fiber Cabling Components Standard
 - .5 ANSI/EIA/TIA 568.4-D Broadband Coaxial Cabling and Components Standard
 - .6 ANSI/TIA-569-E Telecommunications Pathways and Spaces
 - .7 ANSI/TIA-606-D Administration Standard for Telecommunications Infrastructure
 - .8 ANSI/TIA-607-E Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 - .9 ANSI/TIA-758-C Customer-Owned Outside Plant Telecommunications Infrastructure Standard
 - .10 ANSI/TIA-862-B Building Automation Systems Cabling Standard
 - .11 ANSI/TIA-1152-A Requirements for Field Test Instruments and Measurement for Balanced Twisted-pair Cabling
 - .12 ANSI/TIA-1179-A Healthcare Facility Telecommunications Infrastructure Standard
 - .13 TIA TSB-162-B Telecommunications Cabling Guidelines for Wireless Access Points
 - .14 TIA TSB-184-A Guidelines for Supporting Power Delivery over Balanced Twisted-pair Cabling
- .7 Building Industry Consulting Service International (BICSI)
 - .1 BICSI Telecommunications Distribution Methods Manual (TDMM), 15th Edition or latest
 - .2 Information Transport Systems Installation Manual (ITSIM), 8th Edition or latest
 - .3 Outside Plant Design Reference Manual (OSPDRM), 6th Edition or latest
 - .4 ANSI/BICSI 005-2016 Electronic Safety and Security (ESS) System Design and Implementation Best Practice

1.6 Dimensions and Definite Locations

- .1 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and devices. Any information regarding accurate measurement of building is to be taken on site. Do not scale Drawings, and do not use Drawings for prefabrication work.
- .2 Locations of equipment and materials shown may be altered, when reviewed by Consultant, to meet requirements of equipment and/or materials, other equipment or systems being installed, and of building, all at no additional cost to Contract.

1.7 Coordination

- .1 The Contractor shall refer to shop drawings and submittal drawings for equipment requiring communications connections to verify rough-in and connection locations.
- .2 Based on the systems concept, the main components, and the approximate geometrical relationships, the Contractor shall provide all other components and materials necessary to make the systems fully complete and operational.
- .3 Coordinate arrangement, mounting, and support of communications equipment:
 - .1 To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - .2 To provide for ease of installation and removal of the equipment with minimum interference to other installations or equipment.

1.8 Contract Documents

- .1 Listing of Drawings does not limit responsibility of determining full extent of work required by these Contract Documents. Refer to Architectural, HVAC, Plumbing, Fire Protection, Electrical, Structural, Site Utility and all other Drawings and other Sections that indicate types of construction in which work shall be installed and work of other trades with which work of Division 27 must be coordinated.
- .2 Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.
- .3 Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.
- .4 Information and components shown on riser diagrams but not shown on plans, and vice versa, shall apply or be provided as if expressly required on both.
- .5 Data that may be furnished electronically by the Architect is diagrammatic. Such electronically furnished information is subject to the same limitation of precision as heretofore described. If furnished, such data is for convenience and generalized reference and shall not substitute for Architect's sealed or stamped construction documents.

1.9 Record As-Built Drawings

- .1 The Contractor shall keep a detailed up-to-date record, of the manner and location in which installations are actually made, indexing each drop, backbone, pull box and equipment / racks.
- .2 Record documents are to reflect all changes in work including change orders, field directives, addenda from bid set of Contract Documents, request for information responses, etc. Upon completion of the project, the Contractor shall modify the project electronic drawing and specification files to incorporate this information. Modified documents shall be turned over to the Owner and Consultant in electronic formats. Record drawings shall also include:
 - .1 Locations of buried conduit or similar items. Include buried depth.
 - .2 Field changes of dimension or detail.
 - .3 Changes made by field order or change order.
 - .4 Details not on original contract drawings.
- .3 Take photographs of all concealed equipment in gypsum board ceilings, shafts, underground (buried) piping routes and supports and other concealed, inaccessible work. At completion of work, make copies of photographs with written explanation for each photo. These shall become part of Record Documents.
- .4 Underground and utility work shall be located by distances to landmarks, such as building foundations. Give actual dimensions of everything installed including elevations and elevations at each change in direction.
- .5 Drawings shall also show record condition of details, sections, riser diagrams, control changes and corrections to schedules. Schedules shall incorporate actual manufacturer and make and model numbers of final equipment installation.
- .6 THE CONSULTANT/ARCHITECT WILL NOT CERTIFY THE ACCURACY OF THE RECORD DRAWINGS - THIS IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR.
- .7 When required by the jurisdiction, each trade shall submit the record set for approval by the building department in a form acceptable to the department. Any document format size changes, and supplemental information required for the submittal are the responsibility of the Contractor.
- .8 Quality of Record Documents shall equal or exceed that of original Contract Documents.
- .9 The record documents shall be submitted in electronic media format to the Architect/Consultant for review and approval, prior to Application for Final Payment.

1.10 Discrepancies in Documents

- .1 Where drawings or specifications conflict or are ambiguous, advise the Consultant in writing before Award of Contract. Otherwise, the Consultant's interpretation of contract documents shall be final, and no additional compensation shall be permitted due to discrepancies or ambiguities thus resolved.

- .2 Where drawings or specifications do not coincide with manufacturers' recommendations, or with applicable codes and standards, alert the Consultant in writing before installation. Otherwise, make changes in installed work as the Consultant requires within Contract Price.
- .3 If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specifications, this Contractor shall provide that material, installation, or work which is of the higher, more stringent standard.
- .4 It is the requirement of these contract documents to have the Contractor provide systems and components that are fully complete, operational, and suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component or its coordination with other building elements. In cases such as this, where the Contractor has failed to notify the Consultant of the situation, the Contractor shall provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.

1.11 Requests For Information (RFI's)

- .1 If the RFI is a request to resolve a conflict or an ambiguity, or a request for additional detail, the Contractor's RFI shall include a sketch or equivalent description of Contractor's proposed solution.

1.12 Site Visit

- .1 Before submitting bid, visit and carefully examine site to identify existing conditions and difficulties that will affect work. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions that are visible or readily construed by an experienced observer.
- .2 The Contractor shall visit job site to familiarize himself with the specific location of the new equipment installations in existing areas, to ensure there is adequate access for the installation of equipment. All entries, pathways, corridors, stairwells, etc., that may be used to install equipment shall be investigated. All existing conditions and potential obstructions that may impede access and installation shall be addressed prior to equipment purchasing/ordering.

1.13 Existing Conditions and Preparatory Work

- .1 Before starting work in a particular area of the project, visit site and examine conditions under which work must be performed including preparatory work done under other Divisions/ Sections or other Contracts or by the Owner. Report conditions that might affect work adversely, in writing, through the General Contractor to the Architect via RFI. Do not proceed with work until defects have been corrected and conditions are satisfactory. Commencement of work shall be construed as complete acceptance of existing conditions and preparatory work.
- .2 The documentation of existing conditions was derived from As-Built documents and is in part unverified. Actual existing conditions shall be verified prior to commencement of work.

1.14 Utility Charges

- .1 Include utility fees and charges for any temporary voice, data and TV services.
- .2 Include utility fees and charges for any required work by the voice, data and TV service providers for the completion of the project.
- .3 Utility costs for permanent service shall be paid by the Owner.

1.15 Temporary/ Continuity of Utility Services

- .1 Refer to Division 1 - General Requirements, regarding specific requirements.
- .2 Provide temporary services where project construction schedule requires extended shut downs of existing equipment and/or systems. Temporary services include the necessary equipment and/or systems to maintain continuity of services. Extended shutdowns are interruptions of existing services for a period of time longer than that acceptable to the Owner.
- .3 Do not interrupt existing utility services without written Owner's approval.
- .4 Schedule interruptions in advance, according to Owner's instructions. Submit, in writing, with request for interruption, methods proposed to minimize length of interruption.
- .5 Interruptions shall be scheduled at such times of day and work so that they have minimal impact on Owner's operations.
- .6 Contractor shall coordinate any shutdowns of existing systems as follows:
 - .1 Give proper notice to Owner when making shutdowns; a minimum of fourteen full days is required.
 - .2 Minimize timeline of shutdowns of any system.
 - .3 Provide temporary services where required and perform shutdowns and tie-ins at a time convenient to Owner.
 - .4 Contractor shall be responsible for completing and filing the Owner's shutdown notice questionnaire.
 - .5 Perform required survey and inspection work required by the notice for shut-down.
- .7 Provide all necessary material, tools, and labour as required for the provisions of temporary services.
- .8 Include premium time work associated with interruptions of services and/or shutdowns as necessary to avoid disruption to Owner's operations.
- .9 For communications work associated with any service provider, coordinate with the appropriate service provider.
- .10 Complete a document by trade Contractor as indicating what is being included as part of this bid, and this project.
- .11 For work involving an independent utility company (i.e., non-owner provided utility), Contractor shall coordinate directly with the utility provider all aspects of related work, including shutdowns, tie-ins, capacity impacts, etc.

1.16 Substitutions

- .1 Where the Contractor wishes to use equipment or methods other than those listed by name, that equipment must be approved by the Consultant. To gain approval for equipment not listed, the Contractor shall submit the following to the Consultant for his review:
 - .1 Documentation from the equipment manufacturer indicating where this equipment meets and does not meet the specifications or drawings as written. This documentation shall state exceptions taken to the specification and the reasons for exceptions. Documentation relative to the request shall be submitted on the manufacturer's letterhead and signed by a representative of the manufacturer.
 - .2 Manufacturer's Cut Sheets: Cut sheets shall be originals as are contained in the manufacturer's catalogue.
 - .3 The Contractor shall provide samples of the proposed equipment for the Consultant's review, if requested by the Consultant.
 - .4 The Contractor shall furnish other information or materials as requested by the Consultant to establish equality.
 - .5 The Contractor shall acknowledge that they have reviewed the submission criteria for the request by stamping the submission with a review stamp or acknowledgement by an accompanying letter.
 - .6 Equipment and materials submitted for review without proper documentation shall be rejected without review.
- .2 Materials, equipment, or methods of installation other than those named, shall be in accordance with the general requirements and similar in composition, dimension, construction, capacity, finish and performance.
- .3 Contractors submitting equipment for approval shall include in their bids incidental costs that may result from the use of equipment. Costs shall include, but not be limited to, additional costs that may be incurred by other Contractors whose scope of work is affected by use of the product. The Contractor shall be responsible for those costs even if they do not become evident until after bidding.

1.17 Submittals

- .1 Definitions:
 - .1 Shop Drawings are information prepared by the Contractor to illustrate portions of the work, such as ductwork layout arrangements, in more detail than shown in the Contract Documents.
 - .2 Submittals are a compilation of product data cutsheets fully describing performance, size, connections, colour selection, etc., as provided by the manufacturer.
- .2 Submittal Procedures and Format
 - .1 Proof that final installation drawings have been reviewed by a Registered Communications Distribution Designer (RCDD).

- .2 Review submittal packages for compliance with Contract Documents and then submit to Architect for review. Submit reproducible drawing and two blue- or black-line reproductions of each Shop Drawing larger than 8-1/2 x 11. Submit four sets of each smaller shop drawing. After review, reproducible original of each large Shop Drawing and three sets of each small shop drawing will be returned with reviewer's marks.
 - .3 Submittals and shop drawings shall be submitted COMPLETE, by trade, in heavy-duty three-ring binders. Each binder shall include a Table of Contents identifying each section. Each section shall be arranged in order of specification section and tabbed accordingly. Each item submitted shall reference the article and paragraph of its specification section. Each item specified shall be addressed. If specified item will not be used, state so in submittal with brief explanation. In the instance when a resubmission is necessary, resubmit only the items required; a complete resubmittal containing previously approved data is not required.
 - .4 Provide additional copies of approved submittals/shop drawings as required for full distribution.
 - .5 Shop drawings showing layouts of systems shall contain sufficient plans, elevations, sections, details, and schematics to describe work clearly. They shall be 1/4 inches = 1 foot 0-inch scale unless specified otherwise.
 - .6 Shop drawings and submittals showing manufacturer's product data shall contain detailed dimensional drawings, accurate and complete description of materials of construction, manufacturer's published performance characteristics and capacity ratings (performance data, alone, is not acceptable), electrical requirements and wiring diagrams. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of contract documents.
 - .7 Samples of each type of data/voice jack complete with faceplate;
 - .8 Samples of patch cord;
 - .9 Sample of fibre optic cabling with proposed terminations, and horizontal copper cabling;
 - .10 Sample of proposed labelling of components and wiring;
 - .11 Sample of proposed test sheet;
 - .12 Copy of tester calibration certificate;
 - .13 Written confirmation that telecommunication system vendor is manufacturer's valid certified system vendor for at least duration of contract work and is in good standing at time of Bid submission;
 - .14 Copy of system manufacturer's warranty.
- .3 Required Use of Acceptable Manufacturers on this Project:

- .1 Substitution of products other than those of the acceptable manufacturers specified herein shall not be made. Only the specified items or the comparable product by one of the specified alternate manufacturers shall be submitted. Products by other manufacturers shall not be used on this project.
- .2 Listing of a manufacturer's name for a particular material or piece of equipment does not imply acceptance of all that manufacturer's products. Use of more than one manufacturer to supply any specific material or equipment shall have prior approval of the Consultant.
- .4 Deviations
 - .1 Concerning deviations other than substitutions, proposed deviations from contract documents should be requested individually in writing whether deviations result from field conditions, standard shop practice, or other cause. Submit letter with transmittal of submittals / shop drawings which flags the deviation to the attention of the Consultant.
 - .2 Without letters flagging the deviation to the Consultant, it is possible that the Consultant may not notice such deviation or may not realize its ramifications. Therefore, if such letters are not submitted to the Consultant, the Contractor shall hold the Consultant harmless for all adverse consequences resulting from the deviations being implemented. This shall apply regardless of whether the Consultant has reviewed or approved submittals/shop drawings containing the deviation and will be strictly enforced.
 - .3 Approval of proposed deviations, if any, will be made at the discretion of the Consultant.
 - .4 Where equipment or methods different than those specified are submitted by this Contractor and approved for use by the Consultant and Owner, the installation shall be in full conformance with the intent of these contract documents. All costs related to the use of the different method and/or equipment shall be paid by this Contractor.
- .5 Submittal Dispositions: Submittals will be returned from the Consultant marked as illustrated below:
 - REVIEWED - Submitted data is in compliance with contract document requirements.
 - REVIEWED AS NOTED - Submitted data is generally in compliance with contract document requirements with minor notations; no resubmission required. Address Consultant's notations.
 - REVISE AND RESUBMIT - Submitted data contains deviations, is incomplete, or requires further clarification any of which require resubmission for confirmation.
 - NOT REVIEWED - Submitted data is not required to be submitted for Consultant's review or was incorrectly transmitted to the Consultant for review.
- .6 Responsibility

- .1 Intent of Submittal review is to check for capacity, rating, and certain construction features. The Contractor shall ensure that work meets requirements of contract documents regarding information that pertains to fabrication processes or means, methods, techniques, sequences, and procedures of construction; and for coordination of work of this and other sections.
- .2 Work shall comply with submittal notations to extent that they agree with contract documents. Submittal review shall not diminish responsibility under this Contract for dimensional coordination, quantities, installation, wiring, supports and access for service, nor shop drawing errors or deviations from requirements of contract documents.
- .3 The Consultant's noting of some errors while overlooking others will not excuse the Contractor from proceeding in error. Contract documents requirements are not limited, waived nor superseded in any way by review.
- .4 Inform subContractors, manufacturers, suppliers, etc., of scope and limited nature of review process and enforce compliance with contract documents.
- .5 The Consultant's obligations to review shop drawings and other submittals and to return them in a timely manner are conditioned upon the prior review and approval of the shop drawings or submittals by the Contractor as required in the construction contract and the Contractor's submittal of the shop drawings and other submittals in accordance with a written schedule distributed in advance to the Consultant identifying the dates for the submittal of the various shop drawings and submittals.
- .7 Schedule:
 - .1 Incorporate submittal review period into construction schedule so that Work is not delayed. The Contractor shall assume full responsibility for delays caused by not incorporating the following submittal review time requirements into his project schedule. Working days listed reference the time in the Consultant's office. It does not include transmittal or review time of Contractor or Consultant. If more than five submittals/shop drawings of a single trade are received in one week, allow at least five (5) additional working days, exclusive of transmittal time, for review, each time a submittal/shop drawing is submitted or resubmitted.
- .8 Multiple Re-submittals:
 - .1 The Consultant will review the first submittal from the Contractor and respond with comments and will review one re-submittal for the same item(s) from the Contractor and respond with comments. If the Contractor is required to make subsequent submittals for the same item(s) the Consultant shall be compensated by the Contractor for the time to review each subsequent re-submittal.

1.18 Operating and Maintenance Manuals

- .1 Obtain at time of purchase of equipment, three copies of operation and maintenance manuals for all items. Assemble literature in coordinated manuals with additional information describing combined operation of field assembled units, including as-built wiring diagrams. Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment.

- .2 The manuals shall include the following and shall have an index of contents and tabs for each specification section and each piece of equipment specified in that section and be provided in the order listed below, per specification section.
 - .1 Copies of all approved submittals/shop drawings;
 - .2 Manufacturer's operating and maintenance instructions and parts lists of all items or equipment. Where manufacturer's data includes several types or models, the applicable type or model shall be clearly designated;
 - .3 Riser diagrams;
 - .4 Wiring diagrams;
 - .5 Test records;
 - .6 Warranty documentation;
 - .7 Owner's written acknowledgement of satisfactory completion of instruction period.
- .3 The operation manuals and instructions to the Owner are of prime importance and shall be provided prior to request for final payment.
- .4 Furnish three copies of manuals and one soft copy to Consultant for approval and distribution to Owner. Deliver manuals no less than 30 days prior to acceptance of equipment to permit Owner's personnel to become familiar with equipment and operation prior to acceptance.
- .5 Operating instructions: Upon completion of installation or when Owner accepts portions of building and equipment for operational use, instruct Owner's operating personnel in any or all parts of all systems. Factory-trained personnel shall perform instructions. Owner shall determine which systems require additional instructions. Duration of instructions shall take equipment through complete cycle of operation (at least five working days). Make adjustments under operating conditions.
- .6 If it is desired to provide maintenance manuals in PDF format, the low voltage Contractor shall provide a written request prior to submitting the manuals indicating which equipment manuals they propose to provide in this format.

1.19 Cleaning and Painting

- .1 Rubbish resulting from this work shall be removed and disposed of daily in manner as to be acceptable to the Owner.
- .2 The Contractor shall clean exposed work and equipment, the interior and exterior of cabinets and pull boxes, etc., and remove rubbish and debris resulting from the work.
- .3 Where painted surfaces of equipment have been damaged or rusted during construction, the Contractor shall repair and paint to match original finish.
- .4 Clean other equipment indicated in other sections of the specification for specific equipment.
- .5 Cleaning shall be performed prior to system start-up.

.6 Equipment

- .1 After completion of project, clean the exterior surface of all equipment, including concrete residue, dirt, paint residue, etc.

1.20 Tests and Acceptance

- .1 The operation of the equipment and communications systems does not constitute an acceptance of the work. The acceptance is to be made after the Contractor has adjusted his equipment and demonstrated that it fulfils the requirements of the drawings and the specifications.
- .2 Tests and Acceptance procedures shall adhere to those specified within each Division 27 specification section.
- .3 Delete the following paragraph and sub-paragraphs if a thermographic survey is not desired/required.
- .4 Upon completion of the installation, the Contractor shall furnish certificates of approval from authorities having jurisdiction.
- .5 In the presence of the Consultant and the Owner, the Contractor shall demonstrate the proper operation of miscellaneous systems.
- .6 Perform other test as specifically stated in other sections of the specification for specific equipment.

1.21 Warranty

- .1 Guarantee the Work of this Section in writing for two (2) years following the date of Substantial Completion of the Work of the entire project. If the equipment is used for ventilation, temporary heat, etc. prior to initial beneficial occupancy by the Owner, the bid price shall include an extended period of warranty covering the two (2) years of occupancy, starting from the initial date of beneficial occupancy by the Owner. The guarantee shall repair or replace defective materials, equipment, workmanship, and installation that develop within this period, promptly and to Owner's satisfaction and correct damage caused in making necessary repairs and replacements under guarantee within Contract Price.
- .2 In addition to guarantee requirements of Division 1 and of this specification section, obtain written equipment and material warranties offered in manufacturer's published data without exclusion or limitation, in Owner's name.
- .3 Replace material and equipment that require excessive service during guarantee period as defined and as directed by Consultant.
- .4 Submit copies of equipment and material warranties to Consultant as part of the close-out documents before final payment.
- .5 At end of guarantee period, transfer manufacturers' equipment and material warranties still in force to Owner.
- .6 This Article shall not be interpreted to limit Owner's rights under applicable codes and laws and under this Contract.

- .7 Specific paragraphs of the specification sections may specify warranty requirements that exceed those of this article.
- .8 Use of systems provided under Division 27 for temporary services and facilities shall not constitute final acceptance of work nor beneficial use by Owner and shall not institute guarantee period.
- .9 Provide manufacturer's engineering and technical staff at site to analyze and rectify problems that develop during guarantee period immediately. If problems cannot be rectified immediately to Owner's satisfaction, advise the Consultant in writing, describe efforts to rectify situation, and provide analysis of cause of problem.

1.22 Spare Parts

- .1 Requirements for spare parts are outlines in individual specification sections. Spare parts shall be turned over, unopened, to the Owner as part of the maintenance manual submittal.

1.23 Owner Training

- .1 As part of this contract, the Contractor shall include all labour and materials to train the building Owner on the electrical systems installed. The Contractor shall be responsible for video and audio taping of all Owner training.
- .2 Owner training shall adhere to the training specified in each Division 27 specification section.

PART 2 – PRODUCTS

2.1 General

- .1 Refer to each specific Division 27 Communications specification section for specific details.
- .2 Perform work such that progress of the entire project including the work of other disciplines and divisions shall not be interfered with or delayed.

2.2 Special Responsibilities

- .1 Installation only items:
 - .1 Where the Contractor is required to install items which he does not purchase, he shall coordinate their delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to the time of installation.
 - .2 The Contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this Contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted, this Contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

- .2 Maintenance of equipment and systems:
 - .1 Maintain equipment and systems until final acceptance.
 - .2 Ensure adequate protection of equipment and material during delivery, storage, installation, and shutdown and during delays pending final test of systems and equipment because of seasonal conditions.
- .3 Use of premises:
 - .1 Use of premises shall be restricted as directed by Consultant and as noted below.
 - .1 Remove and dispose of dirt and debris and keep premises clean. During progress of work, remove equipment and unused material. Maintain building and premises in neat and clean condition and perform cleaning and washing required to provide acceptable appearance and operation of equipment, to satisfaction of Consultant.
 - .2 Store materials in a manner that will maintain an orderly, clean appearance. If stored on-site in open or unprotected areas, all equipment and material shall be kept off the ground by means of pallets or racks and covered with tarps.
 - .3 Do not interfere with function of existing sewers and water and gas mains, electrical or mechanical systems and services. Extreme care shall be taken to prevent debris from entering pipe, ductwork, and equipment.
 - .4 Confer with Consultant as to disruption of services or other utilities due to testing or connection of new work to existing. Interruption of services shall be performed at time of day or night deemed by Owner to provide minimal interference with normal operation.
 - .5 Obtain Owner's approval of the method proposed for minimizing service interruption.

2.3 Basket Cable Tray (For Telecommunications Applications)

- .1 Legrand-Cablofil, CSA approved and labelled, basket type cable tray system complete with factory made couplers, fittings, tee sections, elbows, universal dropouts, etc., and required supporting and installation accessories. Features include but are not limited to following:
 - .1 minimum 300 mm x 100 mm (12" x 4") unless otherwise noted on drawings;
 - .2 for climate-controlled indoor applications – welded wire construction of minimum 5 mm (0.197") diameter carbon steel wires and hardware, conforming to requirements of ASTM A510 grade 1008 with black powder coated finish paint to ASTM D 3451;
 - .3 for non-climate controlled applications and corrosive environments – welded wire construction of minimum 5 mm (0.196") diameter stainless steel wires and hardware, conforming to requirements of AISI Type 304L cleaned and passivated to ASTM A 380;
 - .4 continuous, rigid, welded steel wire mesh cable tray system;

- .5 top wire safety edge;
- .6 wire mesh welded at intersections;
- .7 mesh sections having minimum one (1) bottom longitudinal wire along entire length;
- .8 warning signs;
- .9 accessories included as required.
- .2 Prior to start of work, prepare and submit detailed installation drawings, including plans, elevations and sections of proposed tray and routing. Coordinate such drawings with co-ordination drawings of trades. Include for design calculations to determine load limitations.
- .3 Tray to not have sharp edges that may damage cables during running of cables. Final finish to be smooth with no burrs that may damage cables.
- .4 Use manufacturer's trained and certified installers to perform work. Use tools as recommended by and supplied by tray manufacturer. Utilize manufacturer's supplied cutter for cutting tray. Submit with shop drawings, copies of installing technicians' certificates of training on respective tray systems.
- .5 Provide support of a trapeze configuration containing horizontal hanger brackets and vertical threaded rods on each side. Secure rods to brackets as per system manufacturer's instructions. Space supports at maximum 1.5 m (5'), to provide support of loads up to 53 kg/m (36 lbs per foot).
- .6 Where cable tray penetrates fire rated construction, provide ULC listed and labelled, fire stopping and smoke seal materials or fittings to protect integrity of fire rated construction. Install work in compliance with ULC standards and where required by local governing codes, provide suitable for plenum environments.
- .7 Provide tray complete with grounding/bonding provisions, fittings, tee sections, elbows, universal dropouts, expansion fittings, etc., and required supporting and installation accessories. Provide dividers to separate various system cabling to a degree confirmed by Consultant, but typically two (2) dividers in a 300 mm (12") wide tray.
- .8 Provide conduit fittings where conduits enter tray and provide dropouts at ends where cables exit/enter. Supply cable installation rollers for pulling cables safely into tray. System accessories to be supplied by system manufacturer and be as recommended by system manufacturer for specific applications.
- .9 Acceptable manufacturers are:
 - .1 Legrand-Cablofil;
 - .2 Cooper "Flextray";
 - .3 Eaton B-Line;
 - .4 Canadian Electrical Raceways;
 - .5 Hubbell;
 - .6 WBT.

2.4 Sleeves For Raceways And Cables

- .1 Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends with plastic bushing on each of the sleeve.
- .2 Sleeves for Rectangular Openings: Galvanized sheet steel.
- .3 Minimum Metal Thickness:
 - .1 For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
 - .2 For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.5 Firestopping and Smoke Seal Materials

- .1 Asbestos-free, elastomeric materials and intumescent materials, tested, listed and labelled by ULC in accordance with CAN 4-S115-M85, and CAN/ULC-S101-M for installation in ULC designated firestopping, and smoke seal systems to provide a positive fire, water and smoke seal and a fire resistance rating (flame, hose stream and temperature) no less than fire rating for surrounding construction.
- .2 Fire stopping and smoke seal material system to be specifically ULC certified with designated reference number for its specific installation. As part of shop drawing submission, submit copies of firestopping drawings with ULC certificate and number for each specific installation. Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
- .3 Systems to consist of both elastomeric and intumescent materials that are compatible with abutting dissimilar materials and finishes. Coordinate material requirements with trades supplying abutting areas of materials.
- .4 Typically, for openings of up to 250 mm (10") in diameter, provide putty pad type firestop materials equivalent to Specified Technologies Inc. "SpecSeal" intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibres or silicone compounds.
- .5 Typically, for openings of greater than 250 mm (10") in diameter, and for rectangular openings, provide pillow type firestop materials equivalent to Specified Technologies Inc. "SpecSeal" re-enterable, non-curing, mineral fibre core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag.
- .6 For applications where fire rated firestopping cable pathway system is to be special structurally reinforced, reusable and require no or minimal alterations to firestop component when cables are either added or removed, provide Specified Technologies Inc. "EZ-PATH" device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill. Structure to be sturdy enough to stand up to constant modification and use, but maintain its ULC firestopping rating.
- .7 Supply products of a single manufacturer for use on work of this Division.
- .8 Installer to be manufacturer trained and certified on specific product. Submit copy of certificate with shop drawings.

- .9 Include for manufacturer's authorized representative to inspect and verify each installation and application. Submit test report signed and verified by system installer's authorized representative and manufacturer's representative.
- .10 Acceptable certification to also include certification by Underwriters Laboratories of Northbrook IL, using tests conforming to ULC-S115 and given cUL listing published by UL in their "Products Certified for Canada (cUL) Directory".
- .11 Acceptable manufacturers are:
 - .1 Specified Technologies Inc.;
 - .2 3M Canada Inc.;
 - .3 Tremco;
 - .4 A/D Fire Protection Systems;
 - .5 Nelson;
 - .6 Hilti Canada.

2.6 Sleeve Seals

- .1 Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - .1 Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - .1 Advance Products & Systems, Inc.
 - .2 Calpico, Inc.
 - .3 Metraflex Co.
 - .4 Pipeline Seal and Insulator, Inc.
 - .5 Or approved equivalent
 - .2 Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - .3 Pressure Plates: Stainless steel. Include two for each sealing element.
 - .4 Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.
- .2 Installation Testing, Listings and Approvals
 - .1 Installation shall meet material manufacturer's recommendations exactly, particularly regarding safety, ventilation, removal of foreign materials and other details of installation. Dam openings as recommended. Remove flammable materials used for damming and forming seals in fire-rated construction.
 - .2 Sleeve penetration methods shall be water- and gas-tight and shall meet requirements of ASTM E-119 Standard Methods of Fire Tests of Building Construction and Materials.

- .3 Fire-stop penetration seal methods and materials shall be FM-approved and UL-listed as applicable.

PART 3 – EXECUTION

3.1 Common Requirements For Communications Installation

- .1 Measure indicated mounting heights to bottom of unit for suspended items and to centre of unit for wall-mounting items.
- .2 Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- .3 Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- .4 Right of Way: Give to piping systems installed at a required slope.
- .5 Materials and Workmanship:
 - .1 Work shall be neat and rectilinear. Cabling shall run concealed except in communications rooms and areas where no hung ceiling exists. Install material and equipment as required by manufacturers. Installation shall operate safely, without undue wear, noise, vibration or corrosion. Work shall be properly and effectively protected, and pipe and duct openings shall be temporarily closed to prevent obstruction and damage before completion.
 - .2 Except as specified otherwise, material and equipment shall be new. Provide supplies, appliances, and connections necessary for complete and operational installation.
 - .3 Finish of materials, components and equipment shall be as approved by Architect and shall be resistant to corrosion and weather as necessary.
 - .4 The Owner will not be responsible for material and equipment before testing, commissioning, and acceptance.
- .6 Delivery, Storage and Handling:
 - .1 Protect equipment/materials from damage during shipping, storage, handling and installation. Delivery equipment/materials to the site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
 - .2 The Contractor shall provide for enclosed storage, when equipment/materials are stored on-site and prior to building "dry-in", to prevent any damage resulting from inclement weather or construction traffic. Sheet metal/specialties shall not be stored outdoors.

- .3 Equipment exposed to weather during shipping and/or storage on site shall be plastic shrink-wrapped by the manufacturer to prevent damage due to weather and road debris during transportation and thereafter while in storage awaiting installation.
- .4 Prevent dirt and construction debris from accumulating inside equipment (including pipe and conduit, ductwork, fittings, etc.).
- .5 Equipment/materials, stored or installed, found to be damaged shall be replaced with new by the Contractor, to the satisfaction of the Owner and at no additional expense. Do not store equipment with PVC material with exposure to direct sunlight.
- .6 Equipment/materials shall be handled and installed in accordance with manufacturer's instructions.
- .7 Provisions and Installation of Equipment:
 - .1 For all equipment installed external to the building whether on roofs, supports, grade, etc., the installation must comply with wind loading and impact requirements of the applicable codes for this project site.
 - .2 All equipment being furnished on this project, shall be certified by the manufacturer that the equipment item meets the applicable seismic, wind, earthquake and hurricane impact requirements as set forth by the Authority Having Jurisdiction overseeing this project, and as defined in the following codes:
 - .1 International Building Code – Section 1621 "Earthquake Loads"
 - .3 Compliance with the above Paragraphs 2 and 3 can be reduced and/or eliminated if the equipment being provided is located inside a structural building enclosure, designed by a licensed professional Architect and Structural Engineer.
 - .4 Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways, to satisfaction of Architect and in accordance with code requirements. Installation shall permit clearance for access to equipment for repair, servicing, and replacement.

3.2 Installation of Cable Tray

- .1 Provide sample of tray and detailed drawing layout of work prior to start of work, accurately dimensioned and showing required routing, penetrations, connections, bends, supports, etc.
- .2 Obtain required training from manufacturer's representative on any special installation procedures. Install tray in accordance with manufacturer's instructions to suit specific installation requirements. Use manufacturer's recommended tools for cutting and installing tray.
- .3 Drawings are diagrammatic and do not identify required changes in elevations and architectural features. Site measure exact routing and lengths. Provide detailed drawing layout of work prior to start of work, accurately dimensioned and showing required penetrations, connections, bends, etc.

- .4 Install and hang cable tray at maximum 1.5 m (5') centres and in accordance with manufacturer's published literature employing horizontal bracket supported to ceiling slab by vertical threaded rod hangers.
- .5 Do not secure assembly from ductwork, suspended ceiling structures, lighting, etc. Secure rod hangers directly to ceiling slab. Locate supports as not to interfere with removal or opening of covers. Typically locate spans at intervals $\frac{1}{4}$ span from supports, as recommended by tray manufacturer. Refer to drawing details and/or manufacturer's instructions. Include for provision of required seismic restraints as to comply with local governing building code requirements.
- .6 Provide proper fittings in cable tray at points of conduit entry. Terminate conduits at or in tray with proper grommets and bushing terminations.
- .7 Equip tray with necessary wall flanges, dropouts, enclosures, reducers, fittings, and similar accessories required, maintaining effective free cross-sectional area of tray clear of obstructions that might damage conductor insulation during installation.
- .8 Properly secure, adequately support and neatly harness conductors in tray. Seal cable tray penetrations of building fire barriers by means of ULC listed and labelled fire stopping and smoke sealing material.
- .9 Provide continuous paths along entire lengths of cable tray to maintain proper ground continuity. Utilize system manufacturer's proper grounding and bonding fittings and hardware. Ground and bond system as per local governing electrical code requirements.
- .10 File smooth cuts to tray and re-touch with galvanizing compound.
- .11 Install expansion connectors where cable tray crosses building expansion joints.
- .12 After installation is complete, install warning signs on tray in visible locations.
- .13 Inspect tray for rough finishing burrs, sharp edges, and mechanical deficiencies prior to installing of cabling. Eliminate these deficiencies to satisfaction of Consultant, prior to installing cables.

3.3 Firestopping

- .1 Openings in fire rated construction and annular spaces around conduits, cable trays, and other penetrating items shall be protected in accordance with NEC article 300-21. The fire rating of the protective seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the construction is maintained. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."
- .2 Wall or floor penetrations openings shall be as small as possible.
- .3 Openings and annular spaces required by code to be protected shall be protected whether specifically indicated on the plans or not.
- .4 Installation of materials and assemblies shall be in strict accordance with the manufacturer's instructions.

3.4 Sleeve Installation for Communications Penetrations

- .1 Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- .2 Lay out penetration and sleeve openings in advance, to permit provision in work. Set sleeves and conduit in forms before concrete is poured. Provide remedial work where sleeves and conduits are omitted or improperly placed.
- .3 Provide sleeves and packing materials at all penetrations of foundations, walls, slabs (except on grade), partitions and floors. Sleeves shall meet U.L. rated assembly requirements and materials requirements of these specifications.
- .4 Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- .5 Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- .6 Sleeves that penetrate outside walls, basement slabs, footings and beams shall be waterproof.
- .7 Coordinate work carefully with architectural and structural work. Provide core drilling as necessary if walls are poured or otherwise constructed, without sleeves and a wall penetration is required. Provide core drilling as required for penetrations of existing construction. Do not penetrate structural members without Structural Engineer's/Architect's approval.
- .8 Submit a list of the U.L. Listed details that the Contractor intends on using on this project, in all rated walls.
- .9 Where sleeves/ cabling passing through openings are exposed in finished rooms, finishes of filling materials shall match and be flush with adjoining floor, ceiling, and wall finishes.
- .10 Identify unused sleeves and slots for future installation.
- .11 Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- .12 Cut sleeves to length for mounting flush with both surfaces of walls.
- .13 Fill slots, sleeves and other openings in floors or walls if not used. Fill spaces in openings after installation of pipe, duct, conduit, or cable.
- .14 Fill for floor penetrations shall prevent passage of water, smoke, fire, and fumes. Fill shall be fire resistant in fire floors and walls, and shall prevent passage of air, smoke and fumes.
- .15 Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless indicated otherwise.
- .16 Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - .1 Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- .17 Sleeves through floors shall be watertight and shall extend 2 inches above floor surface.

- .18 Submit and coordinate with all trades complete penetration layout drawings showing all openings in building structural members including floor slabs, walls, bearing walls, foundation walls, shear walls, roof penetrations, etc. Indicate and locate, by dimension, all openings that shall be sleeved. Drawings shall be approved by Consultant prior to the preparation of any opening in a structural member.
- .19 Provide 24-gauge galvanized steel sleeves for all walls, floors, including foundation, stem and exterior walls.
- .20 All penetrations into rooms with STC-rated wall assemblies such as conference rooms, sleeping rooms, etc., must utilize an acoustical sealant in addition to any other sealants required for wall ratings.
- .21 Contractor shall maintain complete integrity of all completed waterproofing, weather-proofing, fire rating, and penetrations during construction.
- .22 Interior penetrations of non-fire-rated walls and floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- .23 Fire-rated-assembly penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- .24 Roof-penetration sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- .25 Aboveground, exterior-wall penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- .26 Underground, exterior-wall penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.5 Sleeve-Seal Installation

- .1 Install to seal exterior wall penetrations.
- .2 Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in centre of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 Demolition

- .1 Refer to all drawings for general description of areas requiring demolition.
- .2 Refer to General Contractor's Instructions for all existing equipment and materials that shall remain the property of the Owner.
- .3 Items of value which are not directed to be returned to the Owner shall become the property of the Contractor. Storage or sale of items on the project site is prohibited.

- .4 Protection: Ensure the safe passage of persons in and around the building during demolition. Prevent injury to persons and damage to property. Provide adequate shoring and bracing to prevent collapse. Immediately repair damaged property to the condition before being damaged. Take effective measures to prevent windblown dust.
- .5 Utilities: Maintain all utilities except those requiring removal or relocation. Keep utilities in service and protect from damage. Do not interrupt utilities serving used areas without first obtaining permission from the utility company and the Owner. Provide temporary services as required.
- .6 Except as noted otherwise, remove from the premises, all materials and equipment removed in the demolition work

3.7 Project Close-Out Procedure

- .1 Close-out documentation shall be provided at the end of the project. Close out documentation shall comply with each applicable Division 27 Specification Section.
- .2 It shall be each Contractor's responsibility to personally hand-deliver all the required project close-out checklist items and to obtain Owner's authorized representative(s) signed receipt on all items requiring Owner sign-off.

3.8 Owner Training

- .1 Owner training shall comply with the requirements specified in each Division 27 Specification Section.
- .2 In general, training shall cover all aspects of the operation and human interface with the given system. Training shall include, but not be limited to:
 - .1 General description of the system and operating intent.
 - .2 Review and demonstration of all adjustments and programming available to the Owner.
 - .3 Review of all system display screens and annunciation functions, both audible and visual.
 - .4 Review and demonstration of all required and recommended periodic system/equipment maintenance. Review shall include all required lockout and tagging procedures.
 - .5 Refer to individual specification sections for additional requirements associated with Owner training.
- .3 Training schedule shall be acceptable to the Owner and shall reflect the availability of Owner personnel. Schedule shall be provided fourteen (14) working days in advance of the first training session and shall be approved in writing by the Owner before final dates and times are set.
- .4 The Contractor shall be responsible for video and audio taping of all training. Recording format shall be digital. Verify exact format with the owner prior to commencing.
- .5 A copy of all training video files shall be included with each Operating and Maintenance manual. Additional copies, up to a maximum of three, shall be provided at the Owner's request. Video files shall be copied to USB(s) for distribution to the Owner.

END OF SECTION

PART 1 - GENERAL

1.1 Section Includes

- .1 This section includes a general description of the technical requirements of the physical spaces for communication systems and the supply and installation of all bonding and grounding, pathways, identification, racks, cabinets, multipair backbone cabling, optical fibre backbone cabling, horizontal copper cabling, patch panels, connectors, faceplates, and patch cords.

1.2 References

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- .2 Division 25 Specification Sections apply to this Section.
- .3 Division 26 Specification Sections apply to this Section.
- .4 Division 27 Specification Sections apply to this Section.
- .5 Division 28 Specification Sections apply to this Section.

1.3 Submittals

- .1 Action Submittals:
 - .1 Product data sheets.
 - .2 Shop drawings.
 - .3 Product schedules.
 - .4 Certifications

1.4 Quality Assurance

- .1 Manufacturers Qualifications:
 - .1 All products shall be sourced from a single manufacturer to ensure an end-to-end solution is provided.
 - .2 Manufacturer certification for the installation and testing of both the UTP copper products as well as the optical fibre communications products. Third party certification is not acceptable.
- .2 Installers Qualifications
 - .1 The structured cabling contractor's lead technician or project manager shall have a valid BICSI issued RCDD designation, and a copy of the valid RCDD certificate shall be provided.

PART 2 - PRODUCTS

- .1 Acceptable Manufacturers:
 - .1 Panduit
 - .2 Belden

2.2 Cables

- .1 Horizontal Copper Cables:
 - .1 10 GIG UTP Copper Cable.
 - .2 Category 6A (UTP, 4-pair, minimum 23 AWG, solid copper conductor.
 - .3 Cable jacket suitable for the environment in which it will be installed, and CSA rated accordingly as FT6 (CMP).
 - .4 Compliant with ANSI/TIA-568.2-D Category 6A specifications.
- .2 Single-mode Fibre Optic Backbone Cables:
 - .1 OS2 single-mode fibre optic indoor small diameter trunk cable.
 - .2 Fibre optic cable formed into groups of twelve (12) fibre strands.
 - .3 Cable jacket suitable for the environment in which it will be installed, and rated accordingly as Optical Fiber Non-conductive Plenum (OFNP).
 - .4 Compliant with ANSI/TIA-568.3-E OS2 single-mode fibre optic cable specifications.
- .3 Multi-mode Fibre Optic Fibre Backbone Cables:
 - .1 OM4 multi-mode fibre optic indoor small diameter trunk cable.
 - .2 Fibre optic cable formed into groups of twelve (12), twenty-four (24), forty-eight (48), and ninety-six (96) fibre strands.
 - .3 Cable jacket suitable for the environment in which it will be installed, and rated accordingly as Optical Fiber Non-conductive Plenum (OFNP).
 - .4 Compliant with ANSI/TIA-568.3-E OM4 multi-mode fibre optic cable specifications.

2.3 Patch Panels

- .1 Copper Patch Panels:
 - .1 Modular patch panels with faceplates
 - .2 Mountable to 483mm EIA opening.
 - .3 Includes twelve (12) faceplates.
 - .4 Two (2) rack unit 48-port
 - .5 Black colour.
- .2 Copper Patch Panels (Shielded):
 - .1 Mountable to 483mm EIA opening.
 - .2 One (1) rack unit 24-port
 - .3 Black colour.
- .3 Fibre Optic Patch Panels:
 - .1 Rack mountable optical fibre enclosures
 - .2 Mountable to 483mm EIA opening

- .3 Up to three (3) Fibre Adapter Panels (FAPs), 72 Fibres, one (1) rack unit
- .4 Single-mode Fibre Adapter Panel:
 - .1 12 Duplex LC.
 - .2 OS2 Blue colour.
- .5 Multi-mode Fibre Adapter Panel:
 - .1 12 Duplex LC.
 - .2 OM3/OM4/OM4+ Aqua colour.
- .6 Fibre Patch Panel:
 - .1 HD Flex.
 - .2 One (1) rack unit, 6-port enclosure.

2.4 Connectors

- .1 UTP Modular Jacks:
 - .1 ANSI/TIA-568.2-D compliant 8P8C (RJ-45) Category 6A modular jack, blue.
 - .2 ANSI/TIA-568.2-D compliant 8P8C (RJ-45) Category 6A modular jack, shielded.
- .2 Single-mode Adapter Cassette:
 - .1 LC Duplex Adapter.
 - .2 OS2 Fibre and Standard Loss.
 - .3 Universal Polarity (B).
 - .4 12-port, 24-fiber (2 MPOs).
- .3 Multi-mode Adapter Cassette:
 - .1 LC Duplex Adapter.
 - .2 OM4 Fibre and Optimized Loss.
 - .3 Universal Polarity (B).
 - .4 12-port, 24-fiber (2 MPOs).

2.5 Faceplates

- .1 Single Gang Faceplates:
 - .1 Equipped with two (2) ports which accommodate two (2) Category 6A modular jacks
 - .2 Blank inserts for unused ports matching the faceplate colour.
 - .3 White colour, Stainless steel where required.
- .2 Modular Furniture Faceplates:
 - .1 Equipped with four (4) module spaces port which accommodate two (2) Category 6A modular jacks
 - .2 Blank inserts for unused module spaces matching the faceplate colour.

- .3 Black colour, Stainless steel where required.

2.6 Patch Cords

.1 Category 6A Copper Patch Cords:

- .1 2.13 m (7'), 3.05 m (10'), 4.57 m (15'), and 7.62 m (25') lengths, blue, small diameter series patch cords (for general use).
- .2 2.13 m (7') and 3.05 m (10') lengths, yellow, small diameter series patch cords (for security cameras).
- .3 28 AWG UTP.
- .4 Solid copper insulated conductors, 4-pairs.
- .5 Enclosed in a CSA rated CMP (FT6) jacket.
- .6 Compliant with ANSI/TIA-568.2-D Category 6A specifications.
- .7 Factory terminated with snag-less modular plugs.

.2 Single-mode Optical Fibre Patch Cords:

- .1 LC connectors.
- .2 Enclosed in an Optical Fiber Non-conductive Plenum (OFNP) jacket.
- .3 Compliant with ANSI/TIA-568.3-E OS2 single-mode fibre optic cable specifications.
- .4 Factory terminated at both ends.
- .5 1 m, 2 m, and 3 m lengths, to suit application. Maximum length of 3m.

.3 Multi-mode Optical Fibre Patch Cords:

- .1 LC connectors.
- .2 Enclosed in an Optical Fiber Non-conductive Plenum (OFNP) jacket.
- .3 Compliant with ANSI/TIA-568.3-E OM4 multi-mode fibre optic cable specifications.
- .4 Factory terminated at both ends.
- .5 1 m, 2 m, and 3 m lengths, to suit application. Maximum length of 3m.

2.7 Equipment Enclosures

.1 Consolidation points:

- .1 Passive in-ceiling enclosure.
- .2 8 Rack Units.
- .3 Up to 610 mm (24") in width, up to 610mm (24") in height, and up to 341 mm (13.43") in depth.

2.8 Pathways

.1 Non-Continuous Cable Support:

- .1 J-hooks with sufficient bearing surface to comply with bend radius of high-performance cables.

- .2 Spaced no more than 1.2m apart
- .2 Wire Mesh Cable Tray:
 - .1 High strength steel wires and formed into a standard 50mm by 100mm wire mesh pattern with intersecting wires welded together.
 - .2 Crosswire constructed with shaped wire to provide flat surface (not round crosswire) for cable support
 - .3 Masked at splice points to allow for bonding (to ground) without surface coating removal.
 - .4 Powder coated or hot dipped galvanize. Zinc coating is not permitted.
- .3 Ladder Tray:
 - .1 Ladder tray is not permitted.
- .4 Conduit:
 - .1 EMT Conduits no less than 21mm diameter.
 - .2 Conduits sized to suit the size and quantity of cables being carried in accordance with industry standards including fill rates for straight sections and sections with bends.
 - .3 Installation in accordance with ANSI/TIA-569 standards.
- .5 Pull Boxes:
 - .1 Pull boxes sized in accordance with ANSI/TIA-569 standards to accommodate the number and size of conduits
- .6 Outlet Boxes:
 - .1 Outlet boxes shall be sized to accommodate required conduits.
 - .2 Outlet boxes sized to accommodate required cable quantities and bend radius per ANSI/TIA-568 standards.
- .7 Innerduct:
 - .1 Corrugated non-metallic construction innerduct with required fittings, couplers and any additional accessories required for a complete innerduct system.
 - .2 Include pre-lubricated pull tape.
 - .3 Suitable for the environment in which it will be installed, and CSA rated accordingly as CMR (FT4) or CMP (FT6).
- .8 Pull Cord:
 - .1 Polypropylene of a minimum 200lbs tensile strength to be pulled in all empty conduits and pathways
 - .2 Pull cords with permanent measurement markings.

2.9 Grounding And Bonding

- .1 Grounding and bonding products in conformance with TIA/EIA J-STD-607.
- .2 TMGB:

- .1 Predrilled copper busbar provided with holes for use with standard sized lugs.
- .2 Minimum dimensions of 6mm thick x 100mm wide.
- .3 Length to meet the application requirements and with consideration of future growth.
- .4 Insulated from its support with a minimum of 50mm separation from the wall
- .5 ULC listed
- .3 TGB:
 - .1 Predrilled copper busbar provided with holes for use with standard sized lugs.
 - .2 Minimum dimensions of 6mm thick x 50mm wide.
 - .3 Length to meet the application requirements and with consideration of future growth.
 - .4 Insulated from its support with a minimum of 50mm separation from the wall
 - .5 ULC listed
- .4 TBB:
 - .1 Copper conductor sized in accordance with TIA/EIA J-STD-607 based on length.
 - .2 Minimum size #6 AWG.
 - .3 Green insulated cable jacket suitable for the environment in which it will be installed, and CSA rated accordingly as CMR (FT4) or CMP (FT6).
- .5 Telecommunications Bonding Conductor:
 - .1 Copper conductor sized in accordance with TIA/EIA J-STD-607 based on length, continuous and connected to all sections of cable tray.
 - .2 Minimum size to match the TBB.
 - .3 Green insulated cable jacket suitable for the environment in which it will be installed, and CSA rated accordingly as CMR (FT4) or CMP (FT6).
- .6 Conductor Lugs:
 - .1 Long barrel two-hole lugs
 - .2 Irreversible compression type connections
 - .3 ULC listed

2.10 Plywood Backboards

- .1 Backboards shall be constructed of fire-rated plywood, 19mm thick, minimum 1219mm wide x 2438mm high.
- .2 Backboard paint shall be white in colour, and non-conductive.
- .3 A complete section of the approved fire-rating stamp shall remain visible after painting.

PART 3 - EXECUTION

3.1 Installation

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- .1 Install products in accordance with product manufacturer's written instructions for type, use and general industry standards, to suit specific applications.
- .2 Install all cables to not to exceed the manufacture's requirements for static and dynamic bending and pull forces.
- .3 Install pathways including conduits, innerduct and cable tray parallel or perpendicular to building lines.
- .4 Mount equipment in accordance with manufacturers recommended hardware and fasteners by staff deemed to be qualified by the manufacturer.
- .5 Location:
 - .1 Locate away from sources of electromagnetic interference, mechanical ductwork, and pipes from other mechanical and electrical systems.
 - .2 Avoid installing adjacent to building components that limit expansion such as stairs, elevators, and fixed building walls.
 - .3 Except for the Communications Entrance Rooms, do not locate on exterior walls.
 - .4 Maintain a minimum of 300mm clearance above drop-ceiling to mitigate interference when opening ceiling tiles and ceiling access hatches.
- .6 Horizontal Copper Cables:
 - .1 Ensure that excess pressure is not placed on the cable that may result in the compression or deformation of the cable jacket and internal pair geometry.
 - .2 Cables shall not be scrapped or damaged in any way before, during or after installation. All damaged cable shall be replaced at no additional cost prior to acceptance.
 - .3 Ensure all cables are of sufficient length for vertical runs, wastage, and termination.
 - .4 All cables shall be continuous without splices unless otherwise noted.
 - .5 Untwist pairs at termination point no more than 13mm.
 - .6 All cabling shall be terminated following TIA 568A configuration.
 - .7 Horizontal cables shall not exceed 90m length.
 - .8 Terminate all copper pairs.
 - .9 Permanent-link test and labeling of all cables and patch panels
- .7 Multipair Copper Backbone Cables:
 - .1 Ensure that excess pressure is not placed on the cable that may result in the compression or deformation of the cable jacket and internal pair geometry.
 - .2 Cables shall not be scrapped or damaged in any way before, during or after installation. All damaged cable shall be replaced at no additional cost prior to acceptance.
 - .3 Ensure all cables are of sufficient length to allow for vertical runs, wastage, and termination.

- .4 Install a service loop of 5m at each end.
- .5 All cables shall be continuous without splices unless otherwise noted.
- .6 Terminate all copper pairs.
- .7 Test all copper pairs and provide labels.
- .8 Fibre Optic Backbone Cables:
 - .1 Optical fibre cabling shall be installed in conduit or innerduct.
 - .2 Ensure that excess pressure is not placed on the cable that may result in the compression or deformation of the cable jacket and internal fibre strands.
 - .3 Cables shall not be scrapped or damaged in any way before, during or after installation.
 - .4 Ensure all cables are of sufficient length to allow for vertical runs, wastage, and termination.
 - .5 Install a service loop of 5m at each end.
 - .6 All cables shall be continuous without splices unless otherwise noted.
 - .7 Terminate all strands using fusion spliced pigtails or connectors.
 - .8 Testing of all fibre optic strands and labeling of cables and patch panels.
- .9 Copper Tie-Cables:
 - .1 Comply with manufacturer's recommended installation and bundling requirements for installation. Ensure that excess pressure is not placed on the cable that may result in the compression or deformation of the cable jacket and internal pair geometry.
 - .2 Cables shall not be scrapped or damaged in any way before, during or after installation. All damaged cable shall be replaced at no additional cost prior to acceptance.
 - .3 Ensure all cables are of sufficient length to allow for vertical runs, wastage, and termination.
 - .4 Install a service loop of 1m at each end.
 - .5 All cables shall be continuous without splices unless otherwise noted.
 - .6 Terminate all copper pairs.
- .10 Patch Panels:
 - .1 Installed patch panels in racks or cabinets with no less than four (4) bonding screws.
 - .2 Label all ports with adhesive labels
 - .3 Fully populate all ports
- .11 Connectors:
 - .1 Installation shall be free of dirt and complete with identification labelling.
- .12 Faceplates:

- .1 Ensure faceplates are labelled and level.
- .13 Equipment Racks:
 - .1 Anchor equipment racks to the slab floor
 - .2 Install equipment racks parallel to walls and level to the floor
 - .3 Where equipment racks are installed adjacent to each other in a row, gang racks together using rack gang kits.
- .14 Grounding and Bonding:
 - .1 Ground all equipment in accordance with ANSI/TIA-607.
 - .2 Route the bonding conductor in continuous link using the shortest possible straight-line path.
 - .3 Do not daisy chain grounding and bonding cables.
 - .4 Bond to the TGB any backbone cabling that incorporates a shield or metallic member where the cables are terminated or where pairs are broken out.
 - .5 Bond to the TGB all metallic pathways for structured cabling located within the same room or space as the TGB.
 - .6 Bond to the TGB all equipment racks and network cabinets located within the same room or space as the TGB.
 - .7 Metallic pathways containing grounding conductors where the pathway is bonded to the grounding conductor, no additional bond to the TGB is required.
 - .8 Short metallic pathways (e.g., wall and floor sleeves) are not required to be bonded.
 - .9 Apply antioxidant to all contact areas to control corrosion and reduce contact resistance.
- .15 Pathways:
 - .1 Install cable tray around the room and over the racks and cabinets
 - .2 Where floor penetrations are used, install a 100mm high concrete curb around the penetrations for protection
- .16 Identification Labels:
 - .1 The adhesive cable labels shall meet the legibility, defacement, adhesion, and general exposure requirements specified in UL 969.
 - .2 Self-laminating vinyl construction cable labels with a white printing area and black coloured text.
 - .3 Labels shall be mechanically printed using a laser printer.
 - .4 All labels shall be applied on clean and dry surfaces and shall align accurately.
 - .5 Apply labels to the following locations:
 - .1 On both ends of the cable, within 150mm of the cable termination.
 - .2 On the faceplate above each modular jack.

- .3 On the patch panel above each modular jack and connector.
- .4 On each equipment rack and network cabinet.
- .6 Label all grounding and bonding conductors as indicated in TIA J-STD-607
- .7 Cable jacket, modular jack, and patch cord colours shall be subject to Review by Osler.

3.2 Field Quality Control

- .1 All equipment shall be installed in accordance with the equipment manufacturers' requirements and recommendations.
- .2 Ensure that pre-assigned technical lead and engineering personnel remain fully engaged throughout the project, from the design phase through to commissioning.
- .3 Testing And Commissioning:
 - .1 Perform a permanent link test for all UTP cables and components in accordance with ANSI/TIA-568.
 - .2 Test all fibre optic cables and components using fibre optic tester or OTDR in accordance with TIA-455-8.
 - .3 Test all fibre optic cables bi-directionally at all wavelengths that they support.
 - .4 For any permanent link that fails the test, diagnose the failure and correct. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link meets performance requirements. Provide the final and passing result of the tests for all permanent links in the test results documentation.
 - .5 Test electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance.
 - .6 Provide test reports in hard copies and soft copies in PDF and native software files as part of the As-built documentation and close out package.
 - .7 Manufacturer warranty certification shall also be provided and included within the close-out package.

END OF SECTION

PART 1 – GENERAL

1.1 References

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- .2 Division 25 Specification Sections apply to this Section.
- .3 Division 26 Specification Sections apply to this Section.
- .4 Division 27 Specification Sections apply to this Section.
- .5 Division 28 Specification Sections apply to this Section.

1.2 Definitions

- .1 "OWNER" shall mean the Owner or their appointed representative.
- .2 "ARCHITECT" shall mean the Architect of Record for the project.
- .3 "ENGINEER" shall mean the Electrical Engineer for the project.
- .4 "CONSULTANT" shall mean the Project Security Consultant.
- .5 "CONTRACTOR" shall mean the security system Contractor who shall provide the Building Security System.
- .6 "GENERAL CONTRACTOR" shall mean the General Contractor for the project.
- .7 "ELECTRICAL CONTRACTOR" shall mean the project electrical contractor.
- .8 "FURNISH" shall mean purchase and deliver to the appropriate installing contractor/subcontractor or equipment manufacturer, complete with every appurtenance, document, commission, and warrant.
- .9 "PROVIDE" and "SUPPLY AND INSTALL" shall mean furnish, install, test, commission, and warrant.
- .10 "COMPONENT" shall mean any individual item of equipment, software or material, which is an element of the security system.
- .11 The above definitions shall apply to the words regardless of capitalization.
- .12 Words used in the singular shall not be construed as limiting to one item where other requirements of the contract documents or the scope of work require multiple items and associated accessories to provide a fully functional security system meeting all the requirements detailed in the contract documents.
- .13 When a specific reference to a manufacturer of a product is made, and the terms "or approved equal" are used, substitutions of a product by another manufacturer or model will be permitted, but the substituted product must conform to all specified requirements. A submission including a compliance statement and technical information must be made to the Consultant for consideration.

- .14 The Consultant determination on the acceptability of substitutes shall be final. Approved substitution equipment shall conform to available space, functional, and power requirements. Substituted equipment that does not conform to the requirements shall be replaced or required modifications made at no additional cost to the Owner.
- .15 When a specific reference to a manufacturer of a product is made, and the terms "or approved alternate" are used, substitutions of a product by another manufacturer or model with a cost difference will be permitted. A submission including a compliance statement, technical information, and cost implication must be made to the Consultant for consideration. Areas where the product is not in compliance with the Specifications shall be clearly noted.
- .16 The Consultant determination on the acceptability of substitutes shall be final. Approved substitution equipment shall conform to available space, functional, and power requirements. Substituted equipment that does not conform to the requirements shall be replaced or required modifications made at no additional cost to the Owner.

1.3 Abbreviations

- .1 The following abbreviations shall apply to this and all subsequent sections of the Specifications:
 - ACS - Access Control System
 - AKCS - Automated Key Control System
 - CIS - Computer Interface Station
 - CO - Control Output
 - CPU - Central Processing Unit
 - DRS - Digital Recording System
 - DVR - Digital Video Recorder
 - FAS - Fire Alarm System
 - GSM - Global System for Mobile Communication (Cellular)
 - ICP - Intelligent Control Panel
 - ID - Identification
 - IDS - Intrusion detection system
 - MI - Monitored Input
 - NAS - Network Attached Storage
 - NDR - Network Digital Recorder
 - NDS - Network Data Server
 - NSW - Network Switch
 - NVR - Network video recorder
 - OIW - Operator Interface Workstation

PACS	-	Physical Access Control System
PCS	-	Parking Control System
PIDS	-	Perimeter Intrusion Detection System
RAM	-	Random Access Memory
REX	-	Request to Exit
RFI	-	Request for Information
RFP	-	Remote Field Panel
RM	-	Remote Module
RWS	-	Resident Wandering System
SAN	-	Storage Area Network
SER	-	Security Equipment Room
SIS	-	Security Intercom System
SMD	-	Security Monitoring Desk
VBS	-	Video Badging System
VDW	-	Video Display Wall
VMD	-	Video Motion Detection
VMS	-	Video Management System
WDS	-	Web Data Server
WDU	-	Wall Display Unit
WFP	-	Workstation Flat Panel

1.4 Requirements

- .1 Provide a complete security system turnkey installation as detailed in this and other sections of these specifications. The security system shall comprise of the following systems:
 - .1 All facility CAT6A Network Cables for all ICT scopes of work will be supplied by and installed by the Structured Cable Contractor. Any Local or system only network will be part of each vendor.
 - .2 All facilities Access Control and multi-conductor security cabling by security contractor.
 - .3 An IP-based Video Management System (VMS) throughout the facility as detailed in the security system drawings and specification section 28 23 00. VMS shall be connected to and utilize the property's converged network for communication.
 - .4 Supply and install cameras for the VMS throughout the facility as detailed in the security system drawings and specification section 28 23 00.

- .5 Supply and install sufficient VMS storage for a period of 60 days at a minimum of 15fps, at 1080P resolution, unless otherwise noted. Storage sizing and calculation shall be submitted at time of proposal to ensure sufficient provisions by owner or owner's representative. All event recording shall be pre-buffered for 15 seconds and post-buffered for 15 seconds.
 - .6 In addition to supplied VMS storage, supply an additional 20% storage capacity for future expansion.
 - .7 Supporting networking, signal conversion/transmission devices, servers, workstations, and associated peripherals as detailed on the security system drawings and specifications.
 - .8 For all systems, provide spare materials as detailed in the Execution section of the respective specification section(s).
 - .9 Provide Interfaces & Integration for the security system, subsystems, and to other systems in compliance with drawings and specifications.
 - .10 All equipment installed shall be compliant to either the issued drawings and specifications, approved alternates, or approved in the shop drawing review process. Any equipment found not to be compliant to the contract shall be replaced/reinstalled at no additional cost to the Owner.
- .2 Provide the following for all components of the security system:
- .1 All programming required for a turnkey system until final deficiencies are corrected, and substantial completion is achieved.
 - .2 Warranty on all components furnished, and maintenance/repair/replacement during the warranty period.
 - .3 Submittals, samples and record documentation in compliance with respective sections.
 - .4 Comprehensive commissioning and testing with the Owner or Consultant during substantial completion in compliance with respective specification sections.
 - .5 Training services for the Owner and Operators in compliance with respective specification sections.
 - .6 Coordination with other site trades and contractors/subcontractors.
 - .7 Reporting to the Owner, the Architect and Consultant for the coordinated and timely execution of the Work.
 - .8 All power supplies and conditioners, equipment enclosures, conduit and cable trays, junction and mounting boxes, cabling, sleeves, fire stopping, and other components, software, materials and services required for a completed and fully operational turnkey security system installation meeting these specifications.

1.5 General Criteria

- .1 The security system shall meet the following general criteria:

- .1 All security system equipment, including but not limited to system control panels, networked devices, servers, workstations, interface devices, storage devices shall be fully IP networked, microprocessor based, and feature real time distributed processing.
- .2 The security system shall be configured to ensure reliability of systems operation and control of critical functions/systems. The following describes, in very general terms, a relationship between the various components of the security system that would be acceptable. Other security system topologies shall be acceptable if they meet the intent and performance requirements defined in these specifications.
 - .1 All Network Data Servers (NDS) supporting security system components shall incorporate, at minimum, rack-mountable server grade computers with sufficient NIC bandwidth, video card, processor capabilities, RAM, storage, USB ports to suit the application. The security system NDS computers shall reside in the location(s) noted on the security system drawings.
 - .2 Where requested in the security drawings and specifications, provide a security system Local Area Network (LAN) to serve the security system(s). The security system LAN shall be a high-speed Ethernet TCP/IP based network compliant to telecommunications standards, with either a copper or fibre backbone sufficient to support 10Gbs of network activity.

1.6 Warranty And Services During the Warranty Period

- .1 The Warranty Period for all components of the new security system and their installation shall be a minimum of two (2) years from the date of Substantial Performance. The date of Substantial Performance shall be the date when all components have been certified by the Consultant and accepted by the Owner to be complete in accordance with the definition of Substantial Performance.
- .2 All components and their installations shall be free from defects. Any defective material or workmanship and any resulting damage to work of other trades shall be replaced or repaired as directed during the Warranty Period. Comply with General Conditions, agreeing to repair or replace any components of the security system that have failed within the warranty period.
- .3 Schedule repair work with the Owner's representative to prevent interference with normal building activities.
- .4 The Base Tender price shall include the cost of all replacement parts during the warranty period and all the associated installation costs, and all the costs associated with the repair of components during the warranty period but shall not include the cost of labour for routine maintenance during the warranty period. The cost of labour for routine maintenance during the warranty period shall be provided separately as an Alternate Price as detailed below.

- .5 Replace or repair all supplied defective installations. Respond and be on site within four hours of the Owner placing a system trouble call for items of a critical, urgent, or immediate nature (e.g. failed head end component, non-functioning controller, etc.). Response to Warranty call out by the Owner shall be within 24 hours for items not requiring immediate attention. Work to trouble shoot and identify the cause of the security system or component failure shall begin immediately and shall continue until repaired to the satisfaction of the Owner.
- .6 Any software modifications or upgrades that become standard product offerings from the security system Contractor and/or security system equipment vendors during the warranty period shall be brought to the attention of the Owner and, at the discretion of the Owner, may be requested and, if so, shall be provided at no additional cost to the Owner.
- .7 The security system Contractor shall maintain an inventory of commonly replaced components in the local office for the replacement of failed components. Larger components shall be readily available within the North America for overnight courier shipping response.
- .8 Provide replacement components within the specified time periods for the following components. The Contractor shall guarantee to the Owner that the delivery of replacement components will be provided within the specified time periods.

1.7 Codes, Permits and Approvals

- .1 The latest requirements of all national, provincial, county, municipal and other authorities having jurisdiction shall be met.
- .2 Work that is not clearly defined by local ordinance or amendment shall be governed by the local Building Code, and by the Authorities Having Jurisdiction (AHJ).
- .3 The requirements of The Occupational Health and Safety Act (OHSA), Environmental Protection Act (EPA), Americans with Disabilities Act (ADA), Accessibility for Ontarians With disabilities (AODA) and CSA Barrier Free Design Standards shall be followed for all job-site procedures and installation methods.
- .4 Work shall be performed in compliance with Owner's insurance underwriters' requirements which will be provided to the successful security system proponent following project award.
- .5 All equipment and materials furnished under this contract shall be new and shall meet all applicable UL/ULC standards and all requirements of these specifications.

1.8 Schedule

- .1 Complete all requirements of the security system contract prior to the scheduled Substantial Performance date for each portion of the work.
- .2 Provide to the General Contractor a schedule indicating the sequence of work, durations of individual tasks, delivery dates for all material, devices and equipment and detail any interface that must be coordinated with any other contractors/subcontractors.
- .3 Attend all project meetings as requested by the Owner and the General Contractor.
- .4 Provide written status reports at required intervals and in a format acceptable to the Owner. An updated schedule of work shall be included in each status report.

- .5 Comply with the Project Construction Schedule. Provide additional staff and work overtime as required to comply with the Project Schedule and so as not to interfere with other on-site contractors/subcontractors in their effort to comply with the Project Schedule.
- .6 Provide written Request for Information notices to the Owner when specific information or clarification of the specifications is required. Request for Information notices shall be provided at least two weeks prior to the need for the information.

1.9 Contractor Qualifications

- .1 The Contractor shall:
 - .1 Be certified by the manufacturer to procure, install, program, maintain, and service the acceptable security system components.
 - .2 The Contractor must have permanent full-time certified staff available in the project area to perform all necessary project cycle installation functions, including service and maintenance work following system acceptance.
 - .3 Have staff and be able to supply information to support that their current installation and service technicians are competent factory trained and certified personnel capable of maintaining and servicing the proposed system.
 - .4 Have a proven record of experience with similar in the supply and installation of equivalent systems over a minimum period of five years. Document at least three and no more than six projects, of equal or greater size and complexity, on the acceptable security system components. Indicate quantities of VSS cameras included in the scope of the projects along with a description of the property secured.
 - .5 Have been a factory certified representative for the security system products indicated, for a minimum of three years entailing design, installation, configuration, and maintenance.
 - .6 Have comprehensive local service and support facilities in the project area for the total security systems as provided.
 - .7 Maintain local supplies or have access to a factory authorized organization that shall carry a complete stock of essential and expendable parts.

1.10 System Compliance and Performance Certification

- .1 The security system contractor shall thoroughly review all aspects of the security system design documents and certify that their bid submission and proposed security system facilities are following the Contract Documents.
- .2 The Contractor shall provide a Compliance Review of all Specifications and Addenda as part of the Contractor's proposal. The Compliance Review will be an item-by-item list and review of the Specifications.
- .3 The security system tender Respondents shall clearly identify any areas where the proposed security system facilities are not in full compliance with the security systems design. An accompanying performance statement and technical supporting documentation must be supplied for consideration.

- .4 In lieu of a full Compliance Review, one or more general Letter of Compliance may be supplied if the proposed system(s) are in full compliance with the issued drawings and specifications. A Letter of Compliance from the bidder, contractor/subcontractors, and manufacturers are acceptable.
- .5 Unless an exception is specifically noted in the Compliance Review, it is assumed that the Contractor is in complete compliance with the Contract Documents. Exceptions taken in cover letters, subsidiary documents, by omission, or by contradiction do not release the Contractor from being in complete compliance unless the exception has been specifically noted (explicitly, not by implication) in the Compliance Review.

PART 2 – PRODUCTS

2.1 Equipment – Materials Requirements

- .1 Equipment, materials, devices and facilities shall meet, at minimum, the following requirements:
 - .1 Manufactured by experienced manufacturers of the specific components and facilities.
- .2 All equipment and materials shall be manufactured using new and high-quality components, without defects. All field devices of each system shall be products of one manufacturer with unified shape, colour, design, function, operation, and markings.
 - .1 Design shall minimize the requirement for field repair or maintenance.
 - .2 Modular design to allow expansion without substantial modification of existing installed components.
 - .3 Internal or self-diagnostics for component failures.
 - .4 Maintainable on a unit basis without affecting the ongoing operation of the balance of other systems.
 - .5 Modular components, test ports and cable terminations shall be accessible.
 - .6 Damage caused by the failure of one component will be limited to the component that has failed without affecting the ongoing operation of the systems.
 - .7 Equipment and materials shall be provided with an Underwriters Laboratories, Inc. (U.L.) and Canadian Standards Association C.S.A label wherever applicable.
 - .8 Hazardous Materials Notification: In the event that a product or material that does not contain asbestos, PCB, or other hazardous materials as determined by the Owner is not available, a "Material Safety Data Sheet" (MSDS) equivalent to OSHA Form shall be submitted for the proposed product or material prior to installation.

- .9 Asbestos and PCB Certification: After completion of installation, but prior to Substantial Performance, the security system Contractor shall certify in writing that products and materials installed, and processes used, do not contain asbestos or polychlorinated biphenyls (PCB).

2.2 Equipment – Mounting and Finishes

- .1 Final mounting locations shall be verified with the Architect prior to installation. Notify the Architect if a particular location is not acceptable for the application.

2.3 Ambient Conditions

- .1 Provide equipment, devices and materials for interior applications that shall be capable of withstanding and operate satisfactorily in, at minimum, the following ambient conditions:
 - .1 10 to 45 Deg. Celsius temperatures.
 - .2 10-90 percent relative humidity (non-condensing).
 - .3 Electrical power service of single phase, 85-110 percent of 120 Vac, 60 Hz.
- .2 Provide equipment, devices and materials for exterior applications that shall be capable of withstanding and operate satisfactorily in, at minimum, the following ambient conditions:
 - .1 -40 to 50 Deg. Celsius temperatures.
 - .2 10 - 100 percent relative humidity.
- .3 Electrical power service of single phase, 85-110 percent of 120 Vac, 60 Hz.

2.4 Pathways for Security System Equipment

- .1 All security system cabling shall be in conduit unless otherwise noted. The electrical contractor shall provide the security system required conduits as detailed on the Security Drawings. The security system contractor shall review the Security Drawings and indicate within the tender form if any additional conduit is required. If additional conduit is requested by the security system contractor within the tender submittal, it will be added to the electrical contractor's scope of work. If confirmation is not received at tender time, and subsequently it is determined that additional conduit is required, then the security system Contractor shall provide all additional conduits required for a complete security system installation at no additional cost to the owner. Coordinate with electrical contractor for exact junction box and termination locations for all required conduits.
- .2 Conduit sizes indicated on the drawings are to be considered the minimum size to be installed. Provide larger or additional conduit if required. Security system cabling shall not share conduit with any other cabling. Coordinate installation of conduit with building structure and other trades. All conduits shall be provided complete with "pull-string" for future pulls.

- .3 All security system cabling required to be within conduit, shall be run in its own conduit and shall not share conduit with any other trade. Security system cabling of same type may be combined provided CEC minimum fill requirements are maintained.
- .4 If lubricant is required for pulling of cables through conduits, only wipe on or spray on type shall be utilized. The wipe on or spray on type must be expressly designed for mitigation of wet link insertion loss. Cable damage from pulling of cables is the security Contractor's responsibility and new cable shall be provided at no additional cost to the Owner.
- .5 If a J-hook or trapeze system is used to support cable bundles, all cables shall be supported at a maximum of four-foot intervals- at no point shall cable(s) rest on acoustic ceiling grids or panels.
- .6 Cables supported by J-hooks shall be run in conduits from ceiling area to field device location.
- .7 Structural support members shall be galvanized.

2.5 Panels

- .1 Provide panels and enclosures for all components of the security system which are susceptible to physical or environmental damage. Equipment or devices that are not equipped with enclosures, as a specified unit shall be mounted within panels or enclosures that meet, at minimum, the following requirements:
 - .1 NEMA 1 rated painted steel panels with locking door.
 - .2 Ventilated to prevent excessive heat build-up, where required.
 - .3 Field cabling shall be terminated on a terminal strip or directly on the component PCB fixed within the enclosure. Provide strain relief as necessary.
 - .4 Internal components shall be installed to allow easy access for diagnostics, maintenance, removal, or replacement of any component within the enclosure.
 - .5 Cabling shall be neatly installed within wire guides with removable covers for easy access.
- .2 Interior panels and enclosures within plenum areas shall meet, at minimum, the following requirements:
 - .1 Approved plenum rated panel with locking door and gasketing as required.
 - .2 Field cabling shall be terminated on a terminal strip or directly on the component PCB fixed within the enclosure. Provide strain relief as necessary.
 - .3 Internal components shall be installed to allow easy access for diagnostics, maintenance, removal, or replacement of any component within the enclosure.

- .4 Cabling shall be neatly installed within wire guides with removable covers for easy access and additional service-loop spare cabling common in best industry installation practices.
- .3 Exterior and garage mounted panels and enclosures shall meet, at minimum, the following requirements:
 - .1 NEMA 4 painted steel panels with locking door.
 - .2 Field cabling shall be terminated on a terminal strip or directly on the component PCB fixed within the enclosure. Provide strain relief as necessary.
 - .3 Internal components shall be installed to allow easy access for diagnostics, maintenance, removal, or replacement of any component within the enclosure.
 - .4 Cabling shall be within wire guides with removable covers for easy access.
- .4 All panels shall be lockable with the same key, which shall be unique to the building. Provide the Owner with ten keys.
- .5 Provide cabling diagrams laminated in clear plastic at each field panel enclosure showing all cable terminations, relays, interlocks, power supplies, etc.
- .6 Provide heat output and space conditioning requirements to the Owner and Architect for all security system components.

2.6 Labelling

- .1 Provide labelling for all panels, and enclosures. Labelling shall meet, at minimum, the following requirements:
 - .1 Plastic laminated label, which shall be affixed to the panel or enclosure with rivets or permanent adhesive.
 - .2 Lettering .25-inch high which sharply contrasts with the background.
 - .3 Coordinated with the approved project labelling scheme and consistent throughout the project.
 - .4 Indicated on the record documentation.

2.7 Security Equipment Rack

- .1 Install all required security system equipment as detailed within these documents within the racks in the Main IT room. Refer to the detail drawings within the security drawings for equipment locations and rack quantities.
- .2 Provide all mounting hardware and supports as necessary to mount the equipment within the racks.
 - .1 Provide heat output and space conditioning requirements to the Owner and Architect for all security system components.

2.8 Pathways For Security System Equipment

- .1 Conduit sizes indicated on the drawings are to be considered the minimum size to be installed. Conduit, where required, shall meet, at minimum, the following requirements:
 - .1 Building conduit shall be electrical metallic tubing (EMT), and shall be as follows:
 - .1 "Thin wall" zinc coated steel.
 - .2 ANSI C80.3 and UL-797.
 - .3 Assembled using concrete tight and rain tight gland-ring compression threaded type fittings.
 - .2 Liquid-tight conduit shall be used in wet locations.
 - .3 Flexible connections shall be provided for equipment subject to vibration or movement.
 - .4 Smooth interior surface free of obstructions.
- .2 Junction and pull boxes shall be installed where required by the corresponding electrical code and at locations to facilitate the pulling of cable. Junction and pull boxes shall meet, at minimum, the following requirements:
 - .1 Meet NEMA/CSA and CEC Code requirements with respect to material, gages, dimensions and methods of fastening.
 - .2 UL/ULC approved for the installed application and location.
 - .3 Removable screw cover.
 - .4 Interior boxes shall be galvanized steel.
 - .5 Exterior boxes shall be hot-dip galvanized cast iron with weatherproof covers.
 - .6 100mm² or larger.
 - .7 Securely fastened to the conduit.
- .3 Cable support (J-hooks) shall meet at minimum the following requirements:
 - .1 Shall Comply with UL, UL, NEC and EIA/TIA requirements.
 - .2 Shall be available in diameter sizes of 25mm (1in), 50mm (2in), 75mm (3in) and 100mm (4in).
 - .3 Shall provide a bearing surface of sufficient width to comply with required bend radius of cables.
 - .4 Shall be metal (at least 0.052" thickness) not plastic or any other similar materials to support cabling in fire event.
 - .5 Any fasteners used to affix the cable support shall be metal and fastened to the metal of support.
 - .6 Shall have flared edges to prevent damage while installing cables.

- .7 Shall meet the bend radius support requirements of supporting four (4) times outer diameter (O.D.) per TIA-C.5.3.2.1; all edges shall support a bend radius of 1 ½" or more.
- .8 Shall support bend radius requirements on the "neck" to allow for pathways around corners.
- .9 Shall have a cable retainer wire form to provide containment of cables within the hanger. The cable retainer shall be removable and reusable.
- .10 Shall have an electro galvanized, G60, or powder coated finish.
- .11 Shall have a UL static load rating of 60lb.
- .12 Coloured cable support shall have the two-letter colour code added to the product number.
- .13 Multi-tiered cable support assemblies shall be used where separate cabling compartments are required.
- .14 Manufacturer shall have minimum of five years documented experience in the industry and certified ISO900.
- .4 Coordinate installation of pathways with building structure and other trades. Pathway's installation above accessible ceilings shall be such that there will be no interference with the installation of lighting fixtures, fire protection, air outlets or other devices.
- .5 Colour-code all conduit and fittings with a unique colour at every junction box and at least every 3,000 mm (10 feet) along the conduit.
- .6 Primary communication LAN cable shall not share conduit with any other cable.
- .7 Secondary communication LAN cable shall not share conduit with any other cable.
- .8 Conduit sizes indicated on the drawings are to be considered the minimum size to be installed. Provide any additional conduit required to provide a complete system.
- .9 Pathway installed by the security systems contractor shall be securely mounted in accordance with CEC Regulations and shall be concealed in all high finish/guest areas and areas to which tenants and/or the public have access.
- .10 Pathway shall run parallel or perpendicular to the building lines and shall be installed in a workmanlike manner. Avoid obstructions and crossovers where possible.
- .11 Pathway shall be installed such that any condensation in the conduit cannot run into security system equipment. Where necessary conduit shall enter enclosures from the bottom or shall be sloped up to the enclosure.
- .12 Conduit/cable tray/cable support shall be provided for all security system cables.

PART 3 – EXECUTION

3.1 Boring and Patching

- .1 Provide boring and patching of work as required for a complete security system. Boring and patching shall meet, at minimum, the following requirements:
 - .1 Before boring any structural or fire rated components, obtain the Architects' approval.
 - .2 Make boring with clean, square and smooth edges. Patches shall be inconspicuous in the final installation.
 - .3 Restore fire ratings if boring has violated the fire rated assemblies.

3.2 Sleeves, Cutting, Patching, and Fire Stopping

- .1 The Contractor shall be responsible for the timely placing of sleeves as detailed on the Drawings and the Coordination Drawings for all piping and conduit through walls and partitions, beams, floors and roofs as noted below, while the same are under construction:
 - .1 All concrete or masonry construction.
 - .2 Wall constructions where the penetration must be sealed airtight. Patches for penetrations through walls for Work installed prior to finish application shall be provided by others. 13mm (½")
 - .3 Fire rated wall construction.
- .2 Sleeves shall be at least one size larger than the size of conduit or pipe, including the insulation where applicable; it serves except where "Link Seal" casing seals are used in sleeves through walls below grade.
- .3 Sleeves shall be sized such that the annular space between the sleeve and the conduit will not be less than 13mm (½").
- .4 All conduits passing through concrete or masonry walls above grade shall be at least 18-gauge galvanized steel sleeves.
- .5 Sleeves shall be set flush with finished wall. All sleeves in floors shall extend a minimum of 50mm (2") above the finished floor.
- .6 Sleeves installed in fire rated construction shall be of suitable length and diameter to accommodate the fire safe system used.
- .7 Sleeves set in concrete floor construction shall be at least 16-gauge, galvanized steel. Where the conduit passes through a sleeve, no point of the conduit shall touch the sleeve, and the conduit shall be centred in the sleeve.
- .8 Seal all penetrations in fire rated construction with factory-built devices or with manufactured fill, void or cavity materials "Classified" by Underwriters Laboratories, Inc. for use as a Through Penetration Firestop.
- .9 All firestop devices and systems shall be approved for such use by the authorities having jurisdiction. The firestop system used shall maintain the fire resistance rating of the building component that is penetrated.

- .10 Firestop systems and devices shall comply with ASTM E 814 (UL 1479) for all types of penetrations being sealed. Submittal data for firestop systems shall include the applicable UL System Numbers. Excessive shrinkage of the firestop materials, which would permit the transmission of smoke or water prior to exposure to a fire condition, is unacceptable.
- .11 Where a mastic coating is used to seal the surface of the firestop, the mastic shall be non-hardening.
- .12 The firestop manufacturer's representatives shall instruct the Contractor's representatives in the proper installation procedures so that the penetrations on the Project will be installed in accordance with the UL listing and the manufacturer's recommendations. If it complies with these Specifications, firestop-sealing component/system as manufactured by one of the following manufacturers will be acceptable:
 - .1 Specified Technologies, Inc. Spec Seal Systems or,
 - .2 3M Fire Barrier Penetration Sealing Systems or,
 - .3 Hilti FS-601 Systems
 - .4 Or approved equivalent
- .13 Sleeves penetrating walls below grade shall be standard weight black steel pipe with 1/4" thick steel plate water seal secured to the pipe with continuous fillet weld.
- .14 The water seal plate shall be located in the middle of the wall and shall be 50mm (2") wider all around than the sleeve it encircles. The entire assembly shall be hot dipped galvanized after fabrication.
- .15 Seal off annular opening between pipe and sleeve with "Link Seal" type casing seal as manufactured by Thunderline Corporation or Innerlynx. The pipe sleeve shall be sized to accommodate the Thunderline casing seal.
- .16 Casing seals shall be Series 300 for pipe size 20mm (3/4") through 100mm (4") and Series 400 for pipe sizes 125mm (5") and larger. If holes and/or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no additional expense to the Owner.
- .17 The Contractor shall undertake no cutting or patching without first securing the Architect's written approval.
- .18 All unused sleeves shall be sealed with firestop devices and systems to maintain the fire rating of the construction penetrated.

3.3 Labelling

- .1 Provide labelling for all cabling. Labelling shall meet, at minimum, the following requirements:
 - .1 Plastic laminated label, which shall be affixed to the cable with self-adhesive backing.
 - .2 Marker labelling directly on the cable jacket shall not be permitted.
 - .3 Lettering which sharply contrasts with the background.

- .4 Coordinated with the approved project labelling scheme and consistent throughout the project. Approve with consultant prior to labelling.
- .5 Indicated on the record documentation.

3.4 Hanging and Supporting

- .1 Install all equipment, devices, materials, and components in compliance with the manufacturer's recommendations. Supports shall be suitable for the environment within which the component is to be installed. Coordinate all hanging and supporting of components with all trades.
- .2 Security system cables shall be bundled in groups of not greater than forty (40) cables. Attention to cable bundle size must be taken; excess of forty (40) cables may cause deformation of the bottom cables within the bundle.
- .3 Cable shall be installed above fire-sprinkler and systems and shall not be attached to the system or any ancillary equipment or hardware.
- .4 The cabling system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- .5 Cables shall not be attached to ceiling grid or lighting support wires.
- .6 Cable damaged (conductor, shield or jacket) or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.
- .7 No plastic or metal cable ties are permitted.
 - .1 Allowable fill capacity and load rating shall not exceed manufacturer recommendation.

END OF SECTION

PART 1 - GENERAL

1.1 Section Includes

- .1 ACS includes but not limited to field devices, termination hardware, supporting hardware, and miscellany required to provide a fully functional integrated ACS, include all equipment, labour, supervision, tooling, and miscellaneous mounting hardware and consumables to install ACS.
- .2 Design, procure, install, integrate, test, and maintain an ACS.

1.2 Reference Standard

- .1 IEEE 802.3, IEEE Standard for Ethernet
- .2 SIA GB-01, Glass break False Alarm Reduction Standard
- .3 SIA PIR-01, PIR False Alarm Immunity Standard
- .4 UL 294, Standard for Access Control System Units Access Control System Units
- .5 UL 609, Local Burglar Alarm Units and Systems
- .6 UL 1076, Proprietary Burglar Alarm Units and Systems
- .7 UL 1635, Standard for Digital Alarm Communicator System Units
- .8 UL 1950, UL Standard for Safety of Information Technology Equipment, Including Electrical Business Equipment

1.3 Submittals

- .1 Contractor shall submit the finalized design data for Review to owner in PDF or CAD editable format prior to any work being done in accordance with Project Agreement.

PART 2 - PRODUCTS

2.1 Design and Performance Requirements

- .1 General Scope:
 - .1 The system shall be an IP based, non – proprietary, redundant, enterprise solution. The system shall be a complete solution that is scalable from the existing scope of this project to several thousand doors across multiple sites which can be added on a unit-by-unit basis. This future expansion capacity shall not require significant replacement or upgrading of hardware or equipment provided as part of the initial solution.
 - .2 The ACS shall be fully integrated with the VSS, and SIS Systems as well as provide all integration as described and required under the division 27 sections.
 - .3 All system testing shall follow the testing, commissioning and acceptance process outlined in Section 28 08 00 - Commissioning of Electronic Safety and Security.
 - .4 Provide detailed door wiring diagrams. Finalize the wiring diagrams to meet any site-specific conditions and provide a fully functional system.

- .5 Provide and include all costs as a part of his proposal for a Specialty Engineer to be present at all testing and commissioning of the system. Provide the Specialty Engineer access to all points of the installation. Provide all test and access equipment required for the inspection.
- .2 System Description:
 - .1 The ACS shall consist of field and termination equipment necessary to provide a fully automated system to control and monitor authorized traffic in and out of controlled areas of the facility.
 - .2 The ACS shall be designed on a distributed processing architecture employing remote DGP's and operator workstations connected to a redundant central server solution.
 - .3 Connect all doors and devices to centrally located DGP panels located in communications rooms.
 - .4 Connectivity from the DGP panels to the system front end shall be based on Ethernet IP based protocols over a converged supplied network.
 - .5 Each DGP panel to be configured to a maximum of 75% of its input, output and reader capacity.
 - .6 The field device to Telecommunications Room allocation shall be identified by contractor ensure that such allocations do not cause cable lengths to exceed a distance of ninety (90) meters regardless of whether the device uses IP or other communication protocols.
 - .7 System monitoring shall be centrally located in the locations indicated in the OS. System monitoring shall also be provided via web browser accessible from any workstation on the converged network. Access shall require a valid user ID and password.
 - .8 The system shall be capable of operating even in the event that the system management server is unavailable.
 - .9 Following a power failure and the restoration of main or backup power, the ACS shall revert automatically, within three and half (3.5) minutes, to normal service status without the need for operator intervention. The system shall restart in the same state as existed before the power interruption with no loss of functionality or transaction data.
 - .10 In the event that communication between the DGP and access control server is unavailable, the functionality of the DGP shall be preserved such that door functionality at every door shall is unaffected.
 - .11 This shall apply for all card records that were recorded in the access control system database prior to the loss of communication between the DGP and access control system server.
 - .12 The ACS shall provide continuous unattended access control and alarm monitoring at specified locations while meeting the technical, operational and feature requirements of this specification.

- .13 The ACS shall grant or deny access within one (1) second of an access attempt. Alarms shall be fully displayed on client workstations within one (1) second of origination.
- .14 The ACS shall allow no more than one (1) false reject per one thousand (1000) read attempts. A "miss" is an incorrect read of an otherwise valid card.
- .15 Under no circumstances shall a false acceptance be allowed.
- .16 The ACS shall support a minimum of forty thousand (40,000) cards and an unlimited amount of facility codes.
- .17 The system shall be capable of responding to card only, card and PIN/key pad, card and biometrics, card and mobile credentials.
- .18 Full fail over server redundancy is a mandatory requirement of this specification. It is intended that all system configuration and user authentication parameters be contained on a minimum of two (2) fully redundant mirrored system servers with real time replication be supplied and installed separately in the building equipment rooms. In no case shall both servers be installed in the same room.
- .19 The ACS shall include but not be limited to the following elements:
 - .1 Supply install, and maintain new field devices per the OS including, but not limited to:
 - .1 Card readers
 - .2 Keypads/PIN pads
 - .3 Door control units / DGP
 - .4 Door position switch
 - .5 Access cards
 - .6 Tamper alarms
 - .7 Local audio alarms
 - .8 RTE motion detectors
 - .9 RTE push buttons
 - .10 Key switches
 - .11 Interface to door hardware (Power transfer switches/crash bars, strikes, door operators, etc.) including monitoring circuit for "lock status" and or "bond sensors"
- .20 Supply install, and maintain all necessary display and control equipment including, but not limited to:
 - .1 Door control units / DGP
- .21 Equipment shall not carry any logos or text which identifies the Supplier or contractor.
- .22 Portal Definition:

- .1 Common portal functions
- .2 The below functions are general to all doors where applicable, and unless otherwise stated within the respective portal sub-sections:
 - .1 Valid access trigger:
 - .1 The following are valid triggers which shut the door alarms and allow proper access through the respective portal.
 - .2 Valid access card swiped
 - .3 RTE motion detector or pushbutton
 - .4 Remote access granted
 - .5 Valid access card swiped and valid PIN pad input.
- .3 Loss of Power Operation:
 - .1 Non-maglock doors shall fail secure on loss of power to the lock.
 - .2 Doors with maglocks shall fail safe when loss of power occurs.
 - .3 When power is restored maglocks shall not be re-energized Automatically. The master reset key-switch shall have secondary switch in public safety office.(Confirm with Client)
- .4 Intercom:
 - .1 An Intercom icon shall be displayed in the ISMS upon alarm if an intercom station is installed at alarm location.
- .5 Video Surveillance:
 - .1 Upon alarm event e.g. door forced open, or door held open, designated camera(s) at the location of the event shall immediately pan, tilt, and zoom to the appropriate pre-set (position pre-programmed), display on a designated alarm monitor Recording shall be 30fps minimum.
 - .2 When the operator acknowledges the alarm via the ISMS application, the VSS shall automatically acknowledge the alarm in parallel without any additional user intervention.
- .6 Invalid Card Reader Swipe:
 - .1 Upon presentation of an invalid access card, the card reader shall provide an AV indication of the invalid access attempt and video footage of the action by the nearest camera.
- .7 Door Forced Open Alarm:
 - .1 In the event that the Door contact or lock status switch activate without a valid access trigger, generate a door forced open alarm at the ISMS, and activate the local annunciator where permitted by owner.

- .2 Local annunciator shall remain active until door is closed and a valid access card is swiped. Alarm can also be reset by the operator via the ISMS.
- .8 Door Held Open Alarm:
 - .1 Door not closed during shunt time shall activate door held open indication in the monitoring location and activate local annunciator. The system should have the ability to keep the local annunciator active until door is closed and a valid card is swiped. Alarm can also be reset by the operator in the monitoring location.
- .9 Delayed Egress – Panic bar activated:
 - .1 The security system shall be configured with fifteen (15) second delayed egress functionality.
 - .2 Upon panic bar activation, immediately activate the local annunciator, and a three (3) second timer shall start. If the panic bar is released within the first three (3) seconds, deactivate the local annunciator.
 - .3 After the first three (3) seconds of continuous activation of the panic bar, a twelve (12) second time shall start to unlock the door.
 - .4 When the twelve (12) second timer is activated, the VSS system shall immediately switch the appropriate camera(s) and shall record the sequence.
 - .5 After the first three (3) seconds of continuous activation of the panic bar, an alarm shall be generated. Alarm shall be indicated as “Door in Delayed Egress Mode”, which warns the operator that the door shall unlock at the end of a twelve (12) second delay.
 - .6 Upon door unlock, the lock status sensor shall indicate a door unsecure alarm.
 - .7 Upon door opening, the door contact shall indicate a door forced open.
 - .8 Upon initiation of the alarm, the operator workstation monitor shall be automatically switched to the appropriate camera(s).
 - .9 The door shall remain unlocked until the key switch is activated. The door can only be re-secured by activation of the local key switch.
 - .10 Where applicable, the door shall be interlocked (through software at the panel level) with all other downstream doors in the egress path, such that the total egress delay does not exceed fifteen (15) seconds.
- .10 Fire Alarm Release Operation:

- .1 Fire Alarm Release:
 - .1 Doors with magnetic locks that are required to be used exiting or for egress to exit are required to be released when the fire alarm is activated.
 - .2 This interface shall be a hardware relay provided by the fire alarm system and zoned from the fire alarm system. This shall release the door lock immediately and generate a single alarm indicating that the doors are in fire unlock mode, which warns the operator that all the fire egress doors are unlocked and record video footage of the action by the nearest camera. While the door is in fire unlock mode, inhibit the alarms from the lock status monitor. If the door is opened, generate a door forced open alarm for each respective door.
 - .3 Upon fire alarm restore, the maglocks need to be re-energized. This is done by operating a switch available only to authorized personnel.
- .23 Equipment Rooms:
 - .1 Provide cable troughs, conduit, and emergency power circuits for DGP configurations. Cable troughs shall be grounded to earth ground.
 - .2 All Equipment mounted in each DGP configuration shall be mounted on fire rated plywood supplied and installed by contractor.
 - .3 Access control equipment, cable troughs, conduit, and emergency power circuits, and VSS power supplies shall be wall mounted as per Supplier's specifications.
 - .4 Provide emergency electrical panel power monitoring devices for each communications room and connect into the ACS for monitoring.
 - .5 Provide temperature sensor monitoring devices in each of the communications rooms and connect into the ACS for monitoring.
- .24 Network:
 - .1 Ensure all IP addressing schemes used on the converged network are coordinated with and Reviewed by owner.
 - .2 Remote administrator access to be provided to public safety management.
- .25 Interface with Other Systems:
 - .1 VSS:
 - .1 Refer to Section 28 20 00 Video Surveillance System and 28 08 00 Commissioning of Electronic Safety and Security, along with ICAT sections of the Specifications.
- .26 Photo Badge and Verification:

- .1 The system shall be capable of integrating a photo-badge and verification application into the access control system. This application shall have dual functionality:
 - .1 Design photo badge templates.
 - .2 Draw floor maps.
 - .3 Automatically update all owner ACS/Parking with the new badge information including photo.
 - .4 Automatically update HR systems
 - .5 Integrate data into other security systems as applicable.
 - .6 Allow for remote badge printing at any/all owner sites.
- .2 The operator shall have the ability to capture a photo with at least 5MP resolution. The photo capture of a cardholder shall be done by any Twain compatible device, i.e., video capture card, scanner, digital camera, or other. The system shall also provide for importing JPEG or Bitmap images of cardholders.
- .3 The application shall allow a photo to be displayed when viewing cardholder records or online transactions from the guard monitoring application.
- .4 The photo badge and verification application shall provide a suite of tools to draw objects, edit text, and insert database fields to create or modify badge templates.
- .5 The application shall provide an interface for a card printer and be capable of printing cards on one (1) or both sides and overlays at any given time.
- .6 The system shall allow photo verification when a token is read by the reader displaying the cardholder photo in a separate window. The operator shall be able to set the window to show photos of the last ten (10) cardholders whose activity produced a transaction.
- .7 The Maps function shall allow the operator to either import basic AutoCAD drawings (.dwg), graphical file formats, or draw original floor maps and insert icons representing doors and supervised and auxiliary input device locations.
- .8 The operator shall have the option to display a map from a specified access control interface screen to assist in locating the source of the alarm event.
- .27 Power:
 - .1 Connect to the 120 VAC power and for providing CSA listed power supplies and transformers to distribute low voltage power to system components.
 - .2 All power supplies shall be hard wired into source 120VAC power. Plug in transformers are not acceptable.

- .3 Provide lockable, hinged covered, terminal cabinets for all power supplies, transformers, and power distribution terminal strips. Provide all conduit and wiring from the 120 VAC facilities to the terminal cabinets.
- .4 Provide protection against surges, spikes, noise, and other line problems for all system equipment and their components.
- .5 All equipment and system components which are powered by more than 48 volts AC or DC shall be ULC listed for safety. This includes equipment or system components classified as non-power limited.
- .6 All system power supplies shall be monitored, by the ACS, for line failure on a dedicated monitoring input point. Therefore, when an AC line fails, a unique alarm condition shall be caused.

2.2 General Requirements

- .1 Contractor shall be fully responsible for the ultimate design and implementation of the system topology (physical and logical) best suited for the project, given identified and recognized physical infrastructure and constraints. All equipment used shall be natively and fully compatible with the owners ACS indicated in specifications.

2.3 Field Devices

- .1 Door Contact:
 - .1 Door contact shall be supplied and installed by contractor to monitor door status of all security points.
 - .2 Door contact shall be concealed discrete devices unless otherwise specified and shall not be integral to other devices including by not limited to strikes, and maglocks. Where exposed mounting is necessary devices shall be mounted so as to limit easy access to unauthorized personnel.
 - .3 Frame mounted magnetic door contacts, hinge mounted plunger type switches, are not acceptable except for overhead shutters and doors.
- .2 Tamper Alarms:
 - .1 All security equipment cabinets (including VSS, ACS power supply cabinets) shall be equipped with sensors, which detect, locally alarm and remotely annunciate their opening.
 - .2 All AED devices shall be equipped with sensors, which detect, locally alarm, and remotely annunciate their opening and removal.
 - .3 All communication and alarm device cabling at the door and between the DGP and the door shall be supervised to detect and remotely annunciate open, high impedance, low impedance, and short conditions. The end of line supervision device shall be installed as close as possible to the security device.
- .3 Local Annunciator Alarm:
 - .1 All perimeter and parking garage doors shall have a local AV alarm annunciator device.

- .2 The objective of the local alarm is to alert security personnel of unauthorized entry. The annunciator device shall be controllable (On/Off) by the Guard Room operator upon the acknowledgement of the alarm. Alarm shall have been recorded by access control system
- .4 RTE Motion Detector:
 - .1 RTE Motion Detectors shall be supplied and installed by contractor on all security doors that require free egress. The RTE shall mask the alarm when a person is using the door for egress vs other rooms where an additional card reader has been provided on the secure side of the door. RTE shall shunt the door contact alarm only.
 - .2 Activation of the RTE shall not unlock the door.
- .5 Card Readers:
 - .1 Card readers shall be multi-technology as manufactured by HID or approved equivalent.
 - .2 Card reader shall support as a minimum:
 - .1 HID Prox, iCLASS, iCLASS SE, SEOS and MIFARE™ cards
 - .2 HID multi-technology Prox/iCLASS, iClass SE cards and Signo readers.
 - .3 low-current consumption and operate at 5 or 12 VDC.
 - .4 Auto tuning for more consistent read ranges.
 - .3 Card readers shall read the encoded data from the credential and transmit the data to the host panel. The card reader shall also present audio and visual feedback to the user that a card read operation is either "valid" or "invalid".
 - .4 Visual feedback shall be through the use of LED displays at doors with PIN pads or other advanced user interaction.
 - .5 Card readers shall be capable of being flush or surface mounted and shall typically be surface mounted. Flush or recess mounting of card readers is required when normal traffic may cause damage to surface mounted card readers. Provide vandal-resistant and anti-ligature devices and/or enclosures where required.
 - .6 Card reader shall include an integrated PIN pad where required. A separate PIN pad shall not be acceptable.
- .6 Access Cards:
 - .1 Access cards shall be resistive to wear and environmental deterioration and shall be able to be punched to accept chains or clips.
 - .2 The access card shall be dual technology iClass SE and prox. The prox portion of the card shall be compatible with existing card technology currently used by owner, thus allowing for a single credential that can be used at all sites.

- .3 The access card shall have up to eighty-four (84) programmable bits of Wiegand formatted information for universal compatibility with all HID' Wiegand reader applications.
- .4 Ensure that owner is formally consulted to ensure card format and bit structure conform to their standards and allow for multiple site access capabilities where necessary.
- .5 The access card shall be "Passive" (non-battery operated) proximity technology.
- .6 The access card shall have a permanently engraved identification number printed onto it.
- .7 The card numbering shall be:
 - .1 Sequential Matching - The internal identification numbers and the external numbers shall both be sequential and shall match (i.e. internal numbers 1-100, external numbers 1-100).
- .8 The access card shall be capable of having a photo or image printed directly onto the surface of the card with a direct print printer. It shall be offered with multi-colour custom graphics and shall have the option of a slot punch on the short edge of the card for a vertical/portrait format.
- .9 The access card shall be no larger than 8.57 X 5.40 cm, with a maximum thickness of 0.09 cm.
- .10 The access card shall have an operating temperature of -45 to 70 degrees Celsius and shall have an operating humidity of 5-95% noncondensing.
- .11 The read range of the access card shall be extremely consistent, and not affected by body shielding or variable environmental conditions.
- .7 Badge Printer Station:
 - .1 Badge printer station shall be complete with badge printer and tripod mounted digital camera and with automatic capture of highest available image quality.
 - .2 Badge printer shall be of the highest quality and comply to the following minimum requirements:
 - .1 Dual sided,
 - .2 Dye-sublimation/resin thermal transfer,
 - .3 Minimum resolution of 600 dpi minimum.,
 - .4 Capability of supporting up to 16.7 million colours,
 - .5 Shall be compatible with owner supplied access control cards.
 - .3 Printer shall be complete with all consumables such as ribbons, cleaning kits, and any other necessities sufficient for printing the number of cards as indicated in this section.
 - .4 Provide a quantity of two (2) automatic card hole punch tools compatible with HID access cards.

- .5 Camera shall be provided complete with all cables and software for use with PC and printer.
- .8 Microwave-PIR Dual-technology Sensors:
 - .1 Description:
 - .1 Single unit combining a sensor that detects changes in microwave signals and a PIR sensor that detects changes in ambient level of infrared emissions caused by standard-intruder movement within detection pattern.
 - .2 Listed and labeled by a qualified Testing Agency for compliance with SIA PIR-01.
 - .3 Device Performance:
 - .1 An alarm is transmitted when either sensor detects a standard intruder within a period of three (3) to eight (8) seconds from when the other sensor detects a standard intruder.
 - .2 Minimum Detection Pattern:
 - .1 A room 6 by 9 m.
 - .4 PIR Sensor Sensitivity:
 - .1 Adjustable pattern coverage to detect a change in temperature of 1 deg C or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.09 to 2.3 m/s across two (2) adjacent segments of detector's field of view.
 - .5 Microwave Sensor Sensitivity:
 - .1 Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.09 to 2.3 m/s. Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
 - .6 Activation Indicator:
 - .1 LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
- .9 Intrusion Master Control Unit:
 - .1 Description:
 - .1 Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.
 - .2 Intrusion detection system shall be integrated with ACS and shall be capable of remotely arming, disarming acknowledging, and clearing alarms via the primary or secondary monitoring locations, or locally via reader or keypad.

2.4 Display And Control Equipment

.1 DPU:

- .1 The DPU shall be independent and totally self-contained, microprocessor-controlled field panel with built-in Ethernet connection and backup phone modem used to enhance or control a variety of systems. The panel shall serve as the data collection and communications interface between the system server and the various field devices. The low battery fault and power fault outputs of the advanced power system should be looped together and attached to the power fail input on the panel.
- .2 The DPU time shall be synchronized with the system server.
- .3 The DPU shall be comprised of several components including the processor, Ethernet port, serial ports, and expansion connectors which can accept expansion cards. The board shall also include on-board flash memory and sockets for RAM expansion.
- .4 Memory Configurations:
 - .1 The DPU shall support at a minimum 64MB of on-board memory for cardholder and event storage and be capable of being field upgradeable to at least 128MB. There shall be at a minimum 16MB of on-board flash that shall be used for boot code and operating system code.
- .5 Serial Ports:
 - .1 There shall be an RS-232 serial port that may be used for on-site data-retrieval/programming, troubleshooting, or for dialup communication via an external modem.
- .6 Ethernet Port shall support as a minimum 100BaseT Ethernet Communication. The interface to the Ethernet services shall be through a standard RJ-45 jack connector.
- .7 Inputs/Outputs:
 - .1 The DPU shall support dedicated NC inputs to monitor cabinet tamper, power fail and low battery. The system administrative application shall support the configuration of all dedicated inputs connected to the DPU. The monitoring application interface shall provide the status of the inputs and shall log changes in input status. Inputs shall be able to be taken offline for diagnostic purposes and each input shall support being linked directly to an output or to a system event. All input activations shall be reported to the monitoring application and stored in the event history database of the system server.
 - .2 Cabinet tamper contacts shall be normally closed and pre-wired to the enclosure door to report opening of the door as a tamper event.
 - .3 Power fail and low battery inputs shall be normally closed and wired from the battery backup power supply outputs to report main power fail and low battery conditions.
 - .4 Supervised Inputs:

- .1 Class A supervised optically isolated inputs shall be provided on each DPU or associated expansion board.
- .2 The system software administrative application shall support the configuration of all supervised inputs connected to the DPU. The monitoring application interface shall provide the current status of the inputs and shall log changes in input status. Supervised inputs shall be able to be taken offline for diagnostic purposes and each input shall support being linked directly to an output or to a system event. All input activations shall be reported to the monitoring application and stored in the event history database on the system server.
- .5 Outputs:
 - .1 Each DPU or associated expansion board shall provide multiple form C, general-purpose, dry contact relay outputs, which are user configurable. These relay contacts shall be rated at 10A at a nominal voltage of 28VDC/24VAC. Each relay contact shall have MOV's, rated at 56V, between the relay's common terminal and the normally open and normally closed contacts to prolong the contact life and protect the DPU from external devices being controlled by the relay.
 - .2 The system software administrative application shall support the configuration of all outputs connected to the DPU or associated expansion board. The monitoring application interface shall provide the current status of each output and shall allow the manual activation of each output individually or in used defined groups for diagnostic purposes. All output activations shall be reported to the monitoring application and stored in the event history database on the system server.
- .8 Power Requirements:
 - .1 Each DPU shall accept a regulated DC input voltage and generate appropriate voltage levels for on-board use. All power output to external devices shall be current limited by the DPU.
 - .2 All DPU's shall contain a ULC or CSA approved power supply. In such cases where the DPU does not contain a ULC or CSA rating, a separate lockable and tamper monitored external power supply containing these ratings shall be provided.
 - .3 All power supplies shall be hard wired into source 120VAC power. Plug in transformers are not acceptable.
- .9 System Enclosure:
 - .1 Sheet metal, of the appropriate gauge for the cabinet size per UL 294, shall be utilized.
 - .2 The DPU's shall be housed in a locking metal cabinet, suitable for wall mounting. All cabinet locks shall be keyed alike. The cabinet shall be

- suitably sized to allow installation of the controller and all expansion modules and associated field wiring.
- .3 A single tamper switch shall be incorporated into the door.
- .4 Regulatory Approvals - UL 1950, UL 294, and UL 1076, ULC, CSA. All power supplies shall be ULC or CSA approved.
- .2 Operator Workstations:
 - .1 Owner will provide computer workstations where required for administrative and monitoring functions of the ACS. Contractor shall submit the workstation requirements as per the ACS vendor to allow owner to procure the equipment in alignment with contractor's schedule.
 - .2 The configuration should be capable of displaying at a minimum sixteen (16) H.264 video streams at rate of 30fps.
 - .3 Workstation requirements shall include as a minimum the following components. Specifications for these components shall be in compliance with the software developers recommended requirements for all software applications that are installed on the system:
 - .1 Main memory
 - .2 Microprocessor
 - .3 Hard disk drive
 - .4 Two (2) accelerated video cards
 - .5 Network interface card
 - .6 Storage media
 - .7 Mainboard
 - .8 Integrated six (6)-channel soundcard
 - .9 Integrated USB 2.0 controller with four (4) USB 2.0 ports and USB-C ports.
 - .10 Keyboard:
 - .1 101 key enhanced keyboards with USB 2.0 interface. Keyboard shall incorporate soft touch keys and a retractable cord of not less than 2 m in extended length.
 - .11 Mouse:
 - .1 Optical mouse with USB 2.0 interface.
 - .12 Operating System:
 - .1 Most current version of available windows based operating system.
 - .4 Main Memory:

- .1 As recommended by system manufacture, with a minimum requirement of at least 16gb with the ability for further memory expansion..
- .5 Network Interface Card:
 - .1 10/100/1000 Mbps Ethernet Fast Ethernet Controller, IEEE Compliance - 802.3, 802.3u, 802.3x, 802.3z, Compatible with Cat 6 cabling.
- .6 Provide an audible annunciator capability to signal alarm activation to the operator. It shall be possible for the operator to vary the level of the annunciator but not to turn it completely "off". The minimum allowable setting shall be ten (10) dB.
- .7 Provide the capability and program the system to annunciate different alarm signals for the various alarm types.
- .8 Invalid entries by the operator shall be enunciated and displayed on the computer monitors with another altern
- .9 Use appropriate common terms when displaying or printing text. The use of uncommon abbreviations is not acceptable.
- .10 All Guard Room workstations shall be configured for dual 24" LCD 16:9 monitors.
- .11 High Resolution Graphic:
 - .1 The system shall support a minimum of two hundred (200) user programmable color graphic map displays capable of showing the floor plan, location of alarm device, and alarm instructions. Floor plans shall be capable of being imported from other systems such as AutoCAD. All of the graphic maps are to be centralized in the system configuration and shall be displayed on the operator's workstations. Systems requiring separate display monitors or PC are not acceptable.
- .3 Information Storage:
 - .1 All programmed information as well as transactional history shall be automatically stored onto the server hard disk for later retrieval. The system shall warn the operator when the disk space allocation approaches maximum capacity. The system shall allow the system administrator to determine at what percentage of capacity the warnings shall be issued. The system shall further allow the system administrator to define the frequency at which the warnings shall be issued.
- .4 Rack Mounting:
 - .1 All equipment to be located within termination equipment cabinets shall be rack mounted.
- .5 Equipment Cabinets:
 - .1 See Section 28 05 00 - Security System Structured Cabling Requirements.
- .6 KVM:

- .1 See Section 28 05 00 Security System Structured Cabling Requirements.
- .7 Information Backup/Retrieval:
 - .1 The system server(s) shall be capable of transferring all programmed data and transactional history to an appropriate archive storage media. All programmed data shall be restorable from the back-up media in case of system hardware failure.
- .8 Communication Rates:
 - .1 The system shall be capable of supporting 10/100/1000Mbps communication to all access control panels and 10/100/1000Mbps ethernet communications rates to client workstations.
- .9 Printers:
 - .1 The system server shall support report printers. The report printers shall be network printers connected to the Security local area network.
- .10 Communication Ports:
 - .1 Network Ports:
 - .1 The system server shall support the use of ethernet networks as the communications path between the server and DPU's, and other systems for the purpose of integration. This communications path shall be over the same network used for communications between the system server and the operator workstations. The communications between the system server and the field devices shall be encapsulated in a TCP/IP network/transport layer.
 - .2 Port Name:
 - .1 Each communications port shall be addressed with the system by a unique name.
 - .3 Port Description:
 - .1 The system server shall provide the ability to add a communication port description to each port configuration. There shall be no limit to the amount of text that can be used to describe the communications port.
 - .4 On-line/Off-line:
 - .1 The system server shall allow the operator to put a communications port on-line or off-line. If the communications port is placed off-line, the system server shall not use the port to communicate to field device configured on that port. If the communications port is put on-line, the system server shall use the port to communicate to field devices configured on that port.
 - .5 Communication Failure:
 - .1 If the communications port is on a network device, such as a terminal server, the system server shall indicate if there is a loss of communications to that network address. All field units connected to

- that network address should also be reported as being in communications failure.
- .2 To allow for network delays, the system server shall allow the system administrator to define a wait time before annunciation of a communications failure.
- .3 The system server shall provide the administrator the ability to set a reconnect retry period. This is the time period the system shall wait before attempting to re-establish communications with a network port which is in communications failure.
- .4 Configuration of the remote communications port characteristics, i.e. baud rate, parity, error-checking etc. shall be done either on the network device or through network management tools. The configuration is not required to be executed by the central management system.
- .5 IP address:
 - .1 For communications ports on a network device, the system server shall allow the operator to define the IP address of the device, as well as the local port address, to which the remote field devices are connected.
- .11 Encryption:
 - .1 It shall be possible to configure a system such that the communications between the system server and the DPU is encrypted.
- .12 RAID:
 - .1 The system shall support a RAID that provide high performance and fault tolerance. The RAID array shall appear to the system server as a single storage unit or as multiple logical units.
 - .2 RAID 1: The system server shall support the use of RAID level 1. RAID level 1 provides complete data redundancy.
- .13 Redundancy:
 - .1 Through the use of third-party software and associated hardware, the system server shall support a second system server for redundant capability. During normal operation, data shall be written to either server and shall be mirrored to its counterpart in a bi-directional mirroring process.
 - .2 If a failure is detected, it shall be verified across both the network and the mirrored data links. When the failure has been verified, the surviving server shall assume the functions and identities of the failed server without having to sacrifice its own identities or functions. Applications originally running on the failed server are restarted on the surviving server.

2.5 Software

- .1 DPU:
 - .1 General:

- .1 The DPU serves as the data collection and communications interface between the host and the various field devices such as card readers, alarm inputs and control outputs. Communication between the server and the DPU shall be asynchronous. The unit shall consist of a separate general controller module and one or more access control modules.
- .2 The software services are a set of common functions and applications that shall be installed on every DPU to perform system configuration, generic system event handling and communications between the DPU and system server or other DPUs.
- .3 The DPU shall provide for configuration, status and event reporting.
- .4 An ACS selectively allows certain people to enter an area. The DPU shall allow access to identified individuals, shall control entry by time, and shall record entries. The DPU shall also allow a server to control access or allow an access cycle to be controlled by a request-to-exit input.
- .5 The DPU shall perform door and elevator access control. The primary difference between door and elevator is as follows:
 - .1 For a door, the DPU shall operate a single DLR to unlock the door to allow access.
 - .2 For an elevator, the DPU operates multiple relays, (usually one (1) per floor) to enable elevator buttons. When pressed, these buttons instruct the elevator to move to a particular floor where access is then allowed.
 - .3 The DPU shall use a door switch monitor to determine door use, while elevator access control may use floor selection inputs to give feedback about which floor was accessed. There are also differences between door and elevator clearance records. Door clearances contain information about the days and times that a cardholder is allowed to access a specific door, while elevator clearances include additional information about the floors that may be accessed from a particular elevator.
- .2 Communication Services:
 - .1 A set of communications services shall be provided to facilitate communication between the system server and DPU, as well as between DPUs. The service shall also allow configuration of communication ports and shall handle all data encryption and communication protocol specifics.
 - .2 Communications:
 - .1 The ACS shall be designed to support advanced distributed network architecture, whereas DPU's do not need to be home-run wired back to the system database server. Controllers shall be wired at any point on the LAN via industry

- standard TCP/IP communication protocol. DPUs shall be able to communicate back with the system database server through industry standard network switches and routers and shall not be required to reside on the same subnet. Any activity or event within the network can be routed to any client workstation(s) on the network, regardless of the Controller that manages the activity. The system server shall manage any message routing issues, thus isolating the subsystem applications from network-specific communication details.
- .2 The DPU to system server communication shall include authentication IPSEC & 3DES on LAN communication encryption that conform to industry-accepted standards.
 - .3 Upon losing and then restoring communications between a DPU and the system server, database synchronization between the system server and the local database in each controller shall be fast and efficient. Every change made to the controller database shall establish a time/date stamp for the change. When communications are restored, database synchronization shall occur immediately and without system operator intervention. The time-date stamp shall be compared with any changes in the system database, hardware configuration, events, or output control commands and the system server shall log which changes occurred after the off-line event. Any changes made to the system server database while the DPU was off-line shall also be simultaneously downloaded to all DPU databases in the system.
 - .4 Communication between the system server and the DPU shall be asynchronous. The DPU shall not require any poll messages between the system server and the DPU. Messages shall only be transmitted when required and messages can be initiated by any DPU or by the system server. The DPU shall transmit a network heartbeat to the system server to satisfy UL requirements.
- .3 Protocols:
 - .1 Multiple communication techniques may be utilized between the system server and DPU. Communication from controller to controller is via TCP/IP ethernet only.
 - .4 The DPUs shall support Static IP addresses.
 - .5 The DPU shall have RS232 and Ethernet (RJ-45) ports on-board and shall not require external devices to connect to the network.
 - .3 Common System Services:
 - .1 Common system services shall include a system watchdog, event handling services, time management services, software update services, database backup services and diagnostic services.

- .2 The system shall constantly monitor all internal processes and if it detects a problem, it shall reboot the DPU. The DPU shall also reboot automatically if the system software fails to strobe it.
- .3 Software Update Service:
 - .1 The system software shall provide the ability to update the flashed software remotely from a host. Two (2) images of the software shall always be stored, a permanent bootable image and an update image. If the update image becomes corrupt the DPU can fall back to the original image and inform the host to re-send the update image. This feature allows the DPU software to be easily upgraded to add new features or download patches.
- .4 Database Backup to Flash:
 - .1 In the event of an unexpected power-loss, the system software shall automatically save the system and application databases by copying them to the Flash SIMM and restoring them to RAM when power is restored.
- .4 Event Handling Services:
 - .1 The system software shall provide a service that shall serve as a clearinghouse for all activities generated on a DPU. The system server shall upload a list of action definitions and a list of events to each controller. Based on this information, the system shall perform the actions specified for each activity as it is reported. The system software shall provide an interface for reporting activities.
 - .2 Event Linking:
 - .1 Event linking on the system shall tie an activity on one (1) DPU to the triggering of an action on the same or a different DPU. Any conflict of event link requests shall be resolved in the system by means of a server-assigned priority for each event link.
- .5 Action Scheduling:
 - .1 The system software shall provide an action scheduling service that shall execute actions on devices residing on the same or other DPUs at a predefined time, frequency, and time interval. The action definitions shall be the same server-defined actions utilized by event linking. The actions and the action schedule shall be defined by a server and shall be downloaded to the appropriate DPUs. The system shall allow a server to manually invoke a predefined action.
- .6 Offline / Online Reporting:
 - .1 The system shall provide a mechanism to report activities to a server for display, reporting and archiving. If a server is not currently connected to the cluster of DPUs, the activity reports shall be buffered until the server connects to the DPU. Should the server-configured,

activity buffer limit be exceeded before a server connects, the first in first out rule shall apply.

.7 Time Management Services:

- .1 The system shall provide a service to manage user-defined time periods, called time specifications. These time specifications shall be defined on the server and downloaded to all DPUs. The time management services shall also ensure that all controllers have a synchronized time clock. All time periods downloaded shall be defined according to GMT by the host.

.8 Input / Output Services:

- .1 The system software shall allow the configuration and control of inputs and outputs. The software shall allow the retrieving of the current status of the inputs and shall log changes in input and output status. The software shall allow the control of the output including setting the current state to activated, deactivated or momentarily activated.
- .2 Inputs monitored may include, but not limited to:
 - .1 Cabinet tamper, power fail input, and low battery input.
- .3 Input configuration controls the behaviour of the input and includes the following parameters:
 - .1 Enabled/Disabled:
 - .1 A disabled input is not monitored.
 - .2 Reversed:
 - .1 Whether the input should be treated as reversed:
 - .1 Alert report as secure, secure report as alert.
- .4 The DPU shall allow the configuration of input events. These events shall include activation outside a specified time specification causes event.
- .5 Output configuration controls the behaviour of the output and includes the following parameters:
 - .1 Enabled/Disabled:
 - .1 Whether the output is enabled or disabled. Disabled outputs do not react to any output control requests.
 - .2 Reversed:
 - .1 Whether the output is reversed. At the lowest level of control, a reversed output shall have an activate request changed to deactivate and deactivate changed to activate.

.9 Diagnostic Services:

- .1 The DPU shall provide real-time status and diagnostic information to system installers, trouble-shooters and tech support personnel. Based

on this information, a user should be able to determine the connection status, memory status, time and general condition of the controller. Predefined diagnostic tests may be executed, and the results of these tests presented to the user. The following minimal information should be available:

- .1 Controller time/boot time
- .2 Total/available memory
- .3 Connection status
- .4 Firmware and operating system versions
- .5 Total and available memory (RAM)
- .6 Current time information
- .7 Controller type
- .2 The DPU shall provide diagnostic services through either a diagnostic web server, through an RS-232 port supplied by the DPU, and HMI on the controller or any other reasonable method.
- .10 Access Control Services:
 - .1 Door Access Control:
 - .1 The system server shall allow the DPU to handle door configuration and control.
 - .2 Panel Wide Door and Reader Configuration:
 - .1 If card readers include keypads used for PINs, the server may configure the number of digits required in the PIN as well as any other functionality on a panel-wide basis.
 - .3 Door Configuration:
 - .1 The door configuration defines the behaviour of a door and includes the following parameters:
 - .1 Inbound and Outbound Access Readers(s):
 - .1 Which readers are monitored at this door.
 - .2 DSM:
 - .1 A switch that changes state when the door is opened or closed. The switch, if enabled, connects to a monitored input. If the DSM input becomes active while not shunted, it shall generate a door forced open alarm.
 - .3 Door Shunt Time:
 - .1 How long the DSM should be shunted after the door is opened for access. The configuration may also indicate whether the DSM should remain shunted for the full shunt time, instead of clearing when the door

closes. If the DSM remains active after the shunt time expires, it shall generate a door held open event.

.4 RTE Input:

- .1 An input whose activation triggers an access cycle that allows egress through a door. The RTE input should be placed on the protected side of the door. The configuration may indicate whether the DSM should be shunted as long as the RTE is active, and whether the DLR should be enabled for and RTE access.

.5 DLR:

- .1 The output which controls the locking device for the door.

.6 Door Unlock Time:

- .1 The length of time that the DLR is energized during a valid access cycle. The DLR is normally energized for a valid access, and de-energized as soon as the door opens, but a Re-lock Delay may cause the DLR to be energized for a number of seconds after the door opens. Access grant decisions based on presented cards, RTE access based on RTE input activation, and host requests for momentary unlock of the door all cause the DPU to perform a valid access cycle at the door.

.7 Continuous Active Mode:

- .1 A door may be configured for continuous active mode or non-continuous active mode. In non-continuous active mode, each side of the door shall process only one (1) card or RTE access cycle at a time – from the time the card is read or the RTE activates, until the door is opened and closed for the access. During this access cycle, all other cards and RTE requests shall be ignored. In continuous active mode, cards and RTE requests may be processed at any time during the access cycle.

.8 ADA Output:

- .1 An output may be configured to activate at one (1) second after the door is unlocked for valid access, for a duration of one (1) second when the door is being accessed by cardholders with an ADA flag in their personal record.

.9 Expanded Shunt Time:

- .1 For certain cardholders, a longer shunt time may also be configured.

- .4 Door Control:
 - .1 The DPU shall allow door control from a host. The door mode may be set to lock, unlocked momentarily unlocked, or access disabled modes. A momentary unlock request shall start a valid access cycle process on the door.
- .5 Door Status Reporting:
 - .1 The DPU shall report door alarm status changes including door held open and door forced open.
- .6 Door Event Configuration:
 - .1 The DPU shall allow the configuration of events that are activated by certain door event.
- .7 Door Groups:
 - .1 The DPU shall allow the configuration of door groups by a server. Door groups may then be used in roles, or to group doors into specific access roles.
- .8 Reader Configuration:
 - .1 The DPU shall allow reader configuration from a server. The reader configuration defines the behaviour specific to a reader on a door and includes the following parameters:
 - .2 Default PIN Mode:
 - .1 If a card reader includes a keypad, it may be configured to require the cardholder to enter a PIN, in addition to presenting a card, to gain access at a door. A time specification may be entered to control this mode on a time basis.
 - .3 Card Formats:
 - .1 The card formats supported at this reader.
 - .4 Entry Through PIN Pads:
 - .1 For card readers with PIN pads, they may be configured to allow the users to enter their pre-programmed pin number through the PIN pads instead of by presenting a card.
 - .5 Command Entry Through PIN Pads:
 - .1 Card readers with PIN pads, may be configured to allow the user to enter additional command sequences through the PIN pads during the card transaction process.
- .9 Reader Events:
 - .1 The DPU shall allow the configuration of events that are activated by certain reader events:

- .1 Reader communication failure causes event
- .2 Reader tamper causes event
- .10 Interface to Reader Hardware:
 - .1 The DPU shall communicate with reader-bus modules to receive card swipe, and to set the reader LED's and display to communicate access control results to cardholders.
 - .2 The DPU shall support the user of inputs and outputs on the reader-bus modules and on the DPU expansion card for use as door switch monitors, door latch relays, request to exit inputs and any other access control related purposes.
- .11 Card Formats:
 - .1 The DPU shall allow the configuration of card format records describing data that may be read by the card readers. This includes whether the data read from the card is binary (typically from a Wiegand or proximity reader) or BCD (typically from a magnetic card reader), and the length and position of the card number, issue code, any facility or site codes, or parity bits in the data. The API shall allow for specification of which formats are valid at each card reader.
- .12 APB and Area Related Features:
 - .1 The APB feature prevents cardholders from gaining access at a reader and then passing cards back through the door for other people to use. The ACS accomplishes this by keeping track of the area the cardholder is in. If a cardholder attempts to gain access to an area that he/she already occupies, then the ACS assumes that the cardholder passed the card back for another to use and access shall be denied.
 - .2 The APB feature also includes tests for tailgating. The tailgate rule prevents cardholders without using their own access cards. When the ACS receives a request from a cardholder to enter a new area, it checks which are the cardholder last entered. If the area the cardholder is exiting differs from the area the system last recorded the cardholder as entering, the system assumes the cardholder exited the latter area by following someone out.
 - .3 APB and tailgating are tested for any access that leads to or from an area that is configured for APB.
 - .4 The system does not change the recorded area that the cardholder is in until it knows that the cardholder has actually passed through a door. If the door does not have a DSM input or some other means of determining entry, or if the door is open, the system shall record the area change as soon as the admit decision is made. For the case of a door configured as continuously active, where multiple cards may be presented

- before the door is opened; all valid cards shall be recorded as entering into the area when the door finally opens.
- .5 The single-threaded APB role prevents a cardholder from presenting a card at a door and after being admitted, but before opening the door, passes the card to someone else that presents it at an adjacent door and is admitted there. If the system grants access to a cardholder and, before the door is open, detects the same card presented at a second door, the system shall deny the cardholder access at the second door (APB violation), unless all the doors at which the card is presented are configured not to test for any form of APB. The exception to this rule is that if the readers on a particular door are not configured to lead in and out of any area at all, then that door shall not check for single-threaded APB nor shall accesses at that door affect other doors testing for single-threaded APB.
 - .6 Doors whose readers are not configured as part of any area shall not participate in any APB testing, and accesses at that door shall not cause the cardholders location to change, and these accesses shall not be recorded as part of the accesses recorded for timed APB testing. Normally these would be interior doors inside a controlled area.
 - .7 Timed APB:
 - .1 A simpler form of APB, known as timed APB, may be configured for a door. Timed APB is useful for locations where other types of APB are not possible. If the system records that a cardholder uses a card to enter an area more than once in a specified time period, the system assumes that a second person used the same card after the original cardholder entered the area. Timed APB is tested for each access that leads into an area configured for times APB. Due to memory constraints, it is not possible to record every access that a cardholder may make within the re-entry time, but the system shall record the last three (3) accesses entered and test against those to determine if the cardholder's card is being used to re-enter the area.
 - .8 APB Grace Flag:
 - .1 The APB grace flag is an indicator set in a personnel record that allows the cardholder to gain access at a door without being tested for any form of APB. When the cardholder goes through the door, the grace flag is cleared. An API shall be supplied to allow a single or all personnel records to be graced.
 - .9 Area Events:

- .1 The DPU shall provide an API to allow the configuration of events that are activated by certain area events. These include:
 - .1 Entrance:
 - .1 This is activated when a cardholder with an AP Event flag is the personnel record triggers an APB violation while entering the area.
 - .2 Exit:
 - .1 This is activated when a cardholder with an AP Event flag in the personnel record triggers an APB violation while exiting the area.
- .13 Input Services:
 - .1 The DPU shall allow the configuration and control of inputs connected to reader-bus modules and inputs connected to the DPU and any logical input that may be maintained by the DPU.
 - .2 Inputs monitored may include:
 - .1 The inputs directly connected to the DPU.
 - .2 The cabinet tamper and power fail inputs.
 - .3 The inputs connected to readers.
 - .4 The inputs connected to input boards.
 - .5 The tamper inputs on the reader, the input boards, and the output boards.
 - .3 Logical inputs monitored may include:
 - .1 The on-line/off-line condition of any of the reader-bus modules.
 - .2 Door force open and door held open on a door.
 - .3 Input Definition
 - .4 The DPU shall allow the configuration of inputs. Input configuration controls the behaviour of the input and includes the following parameters:
 - .1 Enabled/Disabled:
 - .1 A disabled input is not monitored.
 - .2 Armed/Disarmed:
 - .1 A disarmed input may report secure (or supervision error, if supervised), and armed

- input may report secure, alert, or supervision error.
- .3 Reversed:
 - .1 Whether the input should be treated as reversed – alert report as secure, secure report as alert.
- .5 Input Control:
 - .1 The DPU shall allow the control if inputs including arming/disarming the input.
- .6 Input Status Reporting:
 - .1 The DPU shall allow the retrieving of the current status of inputs and shall log changes in input status.
- .7 Input Event Configuration:
 - .1 The DPU shall allow the configuration of input events.
- .8 Input Groups:
 - .1 The DPU shall allow the configuration of input groups. Input groups may be referenced by events.
- .14 Output Services:
 - .1 The DPU shall allow the configuration and control of outputs connected to reader-bus modules and of outputs connected directly to the DPU.
 - .2 Output Definition:
 - .1 The DPU shall allow the configuration of outputs. Output configuration controls the behaviour of the output and includes the following parameters:
 - .1 Enabled/Disabled:
 - .1 Whether the output is enabled or disabled. Disabled outputs do not react to any output control requests.
 - .2 Reversed:
 - .1 Whether the output is reversed. As the lowest level of control, a reversed output shall have an activate request changed to deactivate and deactivate changed to activate.
 - .3 Output Control:
 - .1 The DPU shall allow the control of outputs, including setting the current state to activated, deactivated, or momentarily activated.

- .4 Output Groups:
 - .1 The DPU shall allow the configuration of output groups. Output groups are useful for elevator definitions, events or other purposes.
- .15 Personnel Database:
 - .1 The DPU shall provide a database to facilitate the storage of personnel data.
 - .2 In addition to the database manipulation functions described below, the DPU shall supply an API to apply APB grace to one (1) or many personnel records.
 - .3 Personnel records used for access control may include the following parameters:
 - .1 Card Number:
 - .1 The number embedded in the access card or otherwise associated with the access request.
 - .2 Control Flags:
 - .1 Such as whether this cardholder may need the ADA output for accesses, or whether the card is currently disabled. These flags include ADA, lost, noticed, AP Event, expired, and disabled.
 - .3 Issue Code
 - .4 PIN
 - .5 Activation/Deactivation Date:
 - .1 Cardholder records typically contain field for an activation and a deactivation date which specify the date/time when the access card becomes valid and invalid, respectively. By setting the activation date, the card can be issued in advance of use; the deactivation date ensures that the card cannot be used after a certain time. The activation date may also be set to after the deactivation date to disable the card for a period of time.
 - .4 Clearance Database:
 - .1 The DPU shall provide a database to facilitate the storage of regular and elevator clearance data. Clearances describe the locations and times at which an access card is valid. Because people often share the same access privileges, clearances are created separately from personnel records. Clearance records

include a varying number of time specification and door group pairs.

.2 Central Management System Server

.1 General:

- .1 Provide a comprehensive Central Management System solution which shall integrate the ACS with VSS, and ICS all communicating across the converged network.
- .2 Provide such a central management system and the associated single GUI for managing the above noted systems within one environment, eliminating the need for a number of separate control systems.

.2 Software Capacities:

- .1 System software and language development software shall be existing, industry accepted, and of a type widely used in commercial systems. Operating system shall be multi-user/multi-tasking capable of operating in a non-proprietary machine. The application software, substantially as offered, shall be written in a high level, industry standard programming language. The system shall be modular in nature, allowing the system capacities to be easily expanded without requiring major changes to the system operation and maintaining all defined system data as well as historical information.
- .2 All system functions shall be accessible via point and click mouse control. Systems requiring command string control or complex syntax are not acceptable.
- .3 The system software shall include the following features and be configured for minimum:
 - .1 One Thousand (1000) readers,
 - .2 Fifty thousand (50,000) active card holder records,
 - .3 Nine hundred and ninety-nine (999) client PC's definable on server,
 - .4 supporting at least two (2) simultaneous printers,
 - .5 One hundred and twenty-eight (128) time schedules,
 - .6 Two fifty-six (256) programmable holidays,
 - .7 Five thousand (5000) input points,
 - .8 Five thousand (5000) output points,
 - .9 Audible alarm annunciation at operator workstation,
 - .10 Two hundred (200) graphic maps to be displayed on the operator workstation monitor,
 - .11 Remote diagnostics, monitoring and user capabilities.
 - .12 Event scheduling,

- .13 An unlimited number of user defined card holder data fields,
- .14 An unlimited number of door groups.
- .15 An unlimited number of areas
- .16 Card holder access privilege activation date and time,
- .17 Clearance activation/expiration date and time
- .18 Interface with ICS
- .19 Interface with Video Surveillance system
- .4
 - .1 DPU communications through hardwired, and Ethernet network.
- .5 Open Database Connectivity
- .6 Language Localization
- .7 Hardware Definitions
- .8 Time Specifications:
 - .1 Holidays:
 - .1 The system software shall allow a maximum of two fifty-six (256) holidays and an unlimited amount of holidays per controller. The system shall support up to twenty-four (24) holiday-lists system wide.
 - .2 Setup:
 - .1 The system software shall have the capacity for a minimum of one hundred and twenty-eight (128) user programmable time specifications. Each time specification shall be comprised of a minimum of eighteen (18) individual time segments.
 - .3 Assignment:
 - .1 The system shall allow a time specification to be assigned to:
 - .1 Access control clearance
 - .2 Inputs/outputs
 - .3 Doors
 - .4 Scheduled functions
 - .5 Alarm events
- .9 Events:
 - .1 Event names
 - .2 System usage

- .3 Event priority
- .4 Configuration
- .10 Action list:
 - .1 The system shall allow an event to be configured to cause other system actions to occur.
- .11 Time Control:
 - .1 It shall be possible to control via a user defined time schedule the period during which an event shall be armed and therefore capable of being activated by other system actions.
- .12 Graphic Map Display:
 - .1 The system shall provide for a graphic map display to be linked to an event. This graphic map shall be available to the system operator to display when responding to the event activation. Graphical maps shall be centralized in the network on a shared disk and be available for display on all operator workstations.
- .13 Automatic Graphic Map Display:
 - .1 The system shall provide automatic display of a graphic map linked to an event. This graphic map shall be available to the system operator to display when responding to the event activation. At the monitoring station, when an event is configured to automatically display a map, a map shall pop up each time the event is activated. The map shall disappear when the event is acknowledged. Graphical maps shall be centralized in the network on a shared disk and be available for display on all operator workstations.
- .14 Alarm Configuration:
 - .1 the system by a unique user defined according to a common naming convention. The use of code numbers or mnemonics shall not be accepted.
 - .2 Alarm description:
 - .1 The system shall provide the ability to add a description text to each alarm point definition to a maximum of one-hundred-and-thirty-two 132 characters.
 - .3 Alarm point configuration:
 - .1 The system shall accept as an alarm input:
 - .1 Supervised alarm inputs, unsupervised alarm inputs and dedicated alarm points such as tamper alarms and controller AC power failure.

- .4 Additional alerts. The system shall also generate alerts for the following:
 - .1 Enclosure tampering
 - .2 Controller communication loss
 - .3 Reader tampering
 - .4 Reader communication loss
 - .5 Alarm tampering (supervised)
 - .6 AC power loss
 - .7 Low battery
- .5 Alarm supervision:
 - .1 When using supervised alarm points, the system shall monitor for open circuit, short circuit, in addition to normal/abnormal conditions.
- .15 Card Record Definitions:
 - .1 Personnel records:
 - .1 Personnel record shall be constructed to contain multiple pages of personnel data in system and user defined fields. card record import\export
 - .2 The system software shall provide means for bulk loading and bulk editing of card records through the use of a data file generated from another source. The external file shall be an ASCII file in comma delimited format.
 - .3 The system shall also provide the ability to generate the same format file of existing card records, allowing the information in the system to be exported to other computers and application. The system shall allow the user to select the card records that shall be included in the export file.
- .16 Global APB
 - .1 Global APB allows multiple DPU clusters to share APB information. Global APB is built on top of cluster APB. Members always ask their Master for the APB decision.
 - .2 The DPU global APB support: current APB location, time of last access, grace state, timed APB, and Area Lockout.
- .17 Reporting:
 - .1 Reporting shall provide for the de-normalization and export of journal data to an external reporting database.
 - .2 Crystal Reports shall be used as the reporting engine to provide pre-defined reports. The end user may use any ODBC-compliant third-party data analysis tool. Examples of these tools are Excel, Crystal Reports, Actuate, and Access.

- .3 The schema of the new reporting database shall be designed with the primary goals of ease of searching, analyzing, and reporting. Compression of data and optimization of real-time performance shall be secondary goals for this database. Indexing of the database shall be designed to achieve the reporting performance goals.
- .4 The user shall be able to customize the filtering of data exported to the reporting database. This shall be implemented by using a monitoring privilege and partition to define the filter, allowing filtering based on message type, object, and person. This can be used to help in minimizing the size of the new database.
- .18 Data Storage:
 - .1 All programmed and transactional history is automatically stored to the hard disk for later recall. Information written to the hard disk shall be immediately available for report generation.
- .19 System Function:
 - .1 The system software shall be able to generate reports without affecting real-time operation of the system.
- .20 Report Types:
 - .1 Programmed data reports shall be available for the following information:
 - .1 Database configuration
 - .2 Historical activity
- .21 Database Configuration Reports:
 - .1 The system shall be capable of producing reports of database configuration information. These database configuration reports shall include the following:
 - .1 Hardware configuration
 - .2 System Configuration
 - .3 Group Reporting
- .22 Activity Reports:
 - .1 Activity reports shall be available for the following:
 - .1 Select the personnel for report
 - .2 Select personnel group for report
 - .3 Select message type for report
 - .4 Select security items for report
- .23 Audit Log Reports:

- .1 Audit trail reports shall be available for the following based on all users or selected users:
 - .2 Audit trail creations
 - .3 Audit trail deletions
 - .4 Audit trail modifications
- .24 Audit Trail:
 - .1 The system shall provide an audit trail function that is intended to record all permanent changes in data configured by system operators. The audit trail shall record permanent changes made to the configuration database by manual operator data entry, import/export or other system controlled devices, such as portable data entry devices. Temporary changes, such as running a report, and querying the card holder database need not be recorded by the audit trail function. Changes made to the system database, outside of the central management system application, such as using ODBC tools, do not need to be recorded by the audit trail function.

PART 3 - EXECUTION

3.1 Installation

- .1 Install products in accordance with product manufacturer's written instructions for type and use.

END OF SECTION

PART 1 - GENERAL

1.1 Section Includes

- .1 Provide all intrusion detection system control panels and associated equipment, power supply, cabling, connectors, enclosures, and all other hardware and software to provide a fully operational system.
- .2 The work covered by this section includes the furnishing, installation, and activation of all equipment & materials associated with complete intrusion detection systems as specified herein. This work may include, integration with the associated subsystems and components listed in these sections.
- .3 The requirements of the conditions of the Contract, Supplementary Conditions, and General requirements apply to the work specified in this section.

1.2 Submittals

- .1 Action Submittals:
 - .1 Product data sheets.
 - .2 Shop drawings.
 - .3 Product schedules.

1.3 References

- .1 Systems specified in this Section shall meet or exceed the requirements of the following:
 - .1 Underwriters Laboratories (UL):
 - .1 UL 365 – Police Station Connected Burglar Alarm Units and Systems
 - .2 UL 609 – Local Burglar Alarm Units and Systems
 - .3 UL 1076 – Proprietary Burglar Alarm Units and Systems
 - .4 UL 1610 – Central Station Burglar-Alarm Units

1.4 Quality Assurance

- .1 Manufacturers Qualifications:
 - .1 All products shall be sourced from a single manufacturer to ensure an end-to-end solution is provided.
 - .2 Where product model is specified and are deemed discontinued by the product manufacturer, provide the latest manufacturer recommend product model at the time of installation in leu of the specified model.
- .2 Product Qualifications
 - .1 Commercial-grade, high quality, and rated for the environment in which it is being installed.
 - .2 All products and materials must be new and approved in the pre-installation submittals.
 - .3 Where product performance specifications are provided, provide the latest manufacturer product model at the time of installation.

1.5 System Requirements

.1 General:

- .1 Provide all intrusion detection system control panels and associated equipment, power supply, cabling, connectors, enclosures, and all other hardware and software to provide a fully operational system.
- .2 These "performance" specifications are to be translated into specific equipment and systems depicting proposed products.
- .3 The Intrusion Detection system shall be an interconnected group of components.
- .4 All components shall be good quality commercial grade consisting of the following devices:
 - .1 Controllers and associated enclosures
 - .2 Communicators and associated enclosures
 - .3 Peripheral devices, Sensors, and accessories
 - .4 Keypads
 - .5 Power supplies
- .5 Where the Intrusion Detection system is integrated with an access control system the Intrusion Detection system shall provide the ability to arm or disarm intrusion zones from outside the protected area.
 - .1 Readers assigned to an armed intrusion zone shall deny access to cardholders unless the intrusion zone is disarmed.
 - .2 Readers assigned to an intrusion zone shall flash LED indicators on the reader to annunciate the intrusion zone status.
 - .3 Cards shall be authorized as to which intrusion zones they can arm and disarm.
 - .4 Users of the system shall enter keypad information to tell the system to arm or disarm and then they shall present their card
 - .5 If the user is authorized to arm zone, and they have active access right for the reader, then the intrusion zone shall be armed and any readers associated with the intrusion zone (other than the arm/disarm reader) shall be placed offline, any inputs associated with the intrusion zone shall be monitored on. An output shall be able to be generated based on the arm event. A history record shall be generated for this event.
 - .6 A configurable time delay before arming a zone shall exist allowing the user to leave the monitored area before the zone is armed.
 - .7 If the user is authorized to disarm the intrusion zone, and they have active access right for the reader, then the intrusion zone shall be disarmed and all readers associated with the intrusion zone shall return to normal operation, any inputs associated with the intrusion zone shall be monitored off. An output shall be able to be generated

based on the disarm event. A history record shall be generated for this event.

- .8 If the user is not authorized to disarm the intrusion zone, but the user has an active access right for the reader, then access shall be denied, and a history record shall be generated.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers:

- .1 DSC
- .2 Or approved equal

2.2 Controllers

- .1 Controller:
 - .1 Minimum 16 zones on main control panel
 - .2 Supports minimum 16 hardwired keypads
 - .3 Expandable up to minimum 128 zones using hardwire, wireless modules, and addressable zones
 - .4 Bus hardwired expansion
 - .5 Minimum 8 partitions
 - .6 Minimum 1,500 user codes (4 or 6 digits)
 - .7 Minimum 3,000-event buffer
 - .8 Minimum 9 accounts and 3 phone numbers
 - .9 Minimum 1 supervised bell zone
 - .10 Built-in telephone line and siren supervision
 - .11 Auto SIA and Contact ID formats
 - .12 Supports multiple types of alarm communicators
 - .13 Full upload/download support with system download software
 - .14 Complete with power supply modules as required Controller
 - .15 Complete with zone expanders as required
 - .16 Approval Listings: FCC/IC, UL/ULC
- .2 Modules:
 - .1 Programmable Input Module
 - .2 Programmable Output Module
 - .3 Wireless Telephone Interface & Automation Control Module: As required
 - .4 TC/IP Integration Module IT: As required

2.3 Controller Enclosures

- .1 All controller enclosures shall be provided to house all controllers.
- .2 All controller enclosures shall be a single key locking metal box.
- .3 Size as required
- .4 Equipped with door tamper switch. Connect each door tamper switch to the intrusion detection system.
- .5 The quantity and size of controller enclosures shall not exceed the real estate provided for mounting controller enclosures. Refer to contract drawings and coordinate as such.

2.4 Communicators

- .1 Internet/Intranet Alarm Communicator: as required
- .2 GSM/GPRS Wireless Alarm Communicator: as required
- .3 Internet and GSM/GPRS Dual-path Alarm Communicator: as required
- .4 Provide communicators as required

2.5 Peripheral Devices, and Sensors

- .1 Magnetic Contacts (Steel)
 - .1 1" dia. contact for use in steel doors.
 - .2 Flush or surface mount as required
 - .3 Self-lock mounting
 - .4 Rugged Construction
- .2 Magnetic Contacts (Wood)
 - .1 1" dia. contact for use in wood doors.
 - .2 Flush or surface mount as required
 - .3 "Wings" protect contact reed from being crushed from swelling wood
 - .4 Superior false alarm immunity
- .3 Magnetic Contacts (Overhead Door)
 - .1 Miniature and low-profile design
 - .2 Stainless steel armored cable for added security and reliability
 - .3 Aluminum bar stock to resist corrosion in harsh environments
 - .4 Floor or track mount as required.
- .4 Passive Infrared Motion Detector
 - .1 Motion detectors shall be masked or oriented to minimize the likelihood of nuisance alarms caused by environmental conditions.
 - .2 All devices shall be wired point to point and to the nearest controller interface.
 - .3 A centralized power supply shall be utilized to power motion detectors.
 - .4 PIR sensitivity adjustment

- .5 Adjustable detection range as required
- .6 Form 'A' or 'C' alarm contact and tamper switch
- .7 Pet immunity
- .8 Tamper-proof
- .9 Ceiling or walls mount as required.
- .10 Colour: White
- .5 Power Supply:
 - .1 Power supplies shall include all controller power supplies, all-electric lock power supplies, and all peripheral device power supplies.
 - .2 All power supplies for controllers and peripheral devices shall provide a backup battery for up to three hours of operation upon loss of AC power. The controller shall retain database information for up to seven days upon loss of power.
 - .3 Agency Listings
 - .1 UL Listed for Access Control Systems (UL294),
 - .2 Power Supplies for use with Burglar-Alarm Systems ULC-S318
 - .3 Hospital Signaling and Nurse Call Equipment (UL1069),
 - .4 Power Supplies for Fire Protective Signaling Systems (UL1481),
 - .5 CUL Listed - CSA Standard C22.2 NO. 205-12, Signal Equipment.
 - .4 Features/Specifications
 - .1 Voltage: output as required.
 - .2 Amperage: Rating as required.
 - .3 Class 2 Rated power limited outputs.
 - .4 PTC (Positive Temperature Coefficient) protected outputs.
 - .5 Fuse rating as required
 - .6 115VAC 60Hz, input.
 - .7 Filtered and electronically regulated outputs.
 - .8 Short circuit and thermal overload protection.
 - .9 Built-in charger for sealed lead acid or gel-type battery backup.
 - .10 Zero voltage drop upon transfer to battery backup.
 - .11 AC input and DC output LED indicators.
 - .12 AC fail supervision.
 - .13 Low battery and battery presence supervision.
 - .14 Fire alarm system interface

PART 3 - EXECUTION

November 14, 2025

3.1 Installation

- .1 Install products in accordance with product manufacturer's written instructions for type, use and general industry standards, to suit specific applications.
- .2 Install the wiring system and integrate the system as indicated in this specification.
- .3 All equipment shall be wall-mounted with sufficient clearance to meet all applicable codes and facilitate observation and testing. All equipment shall be securely fastened with appropriate fittings to ensure positive grounding and be free of ground loops.

3.2 Field Quality Control

- .1 All equipment shall be installed in accordance with the equipment manufacturers' requirements and recommendations.
- .2 Testing And Commissioning:
 - .1 Verify installation of all intrusion detection devices including motion detectors, door/window contacts, glass break sensors, control panels, keypads, and panic buttons in accordance with approved drawings and specifications.
 - .2 Perform functional testing of each intrusion detection device to confirm proper operation. This includes walk tests for motion detectors, open/close tests for magnetic contacts, and simulator tests for glass break sensors.
 - .3 Test system integration with access control and monitoring systems to ensure intrusion events trigger appropriate responses such as lockdowns, alerts, and event logging.
 - .4 Verify alarm signal transmission to the central monitoring station or control software, ensuring all zones and devices report correctly and are logged with accurate timestamps.
 - .5 Test system response under various scenarios including unauthorized entry, tamper conditions, and panic activation to confirm proper alarm activation and notification.
 - .6 For any device or zone that fails testing, diagnose the issue, perform corrective actions, and retest to confirm compliance. Document all corrective actions and include final passing results in the test documentation.
 - .7 Verify power supply and battery backup functionality under simulated power failure conditions to ensure uninterrupted operation of the intrusion detection system.
 - .8 Provide test reports in both hard copy and soft copy formats (PDF and native software files) as part of the As-built documentation and close-out package.
 - .9 Include manufacturer warranty certification for all intrusion detection system components within the close-out package.

END OF SECTION

PART 1 - GENERAL

1.1 Section Includes

- .1 This document defines the VSS and subsystem components to include field devices, termination hardware, supporting hardware, and miscellany required to provide a complete VSS including but not limited to equipment, labour, supervision, tooling, and miscellaneous mounting hardware and consumables to install a complete system.
- .2 Design, procure, install, integrate, test, maintain, and demonstrate a fully functional system which is fully integrated with existing VSS.

1.2 References

- .1 BS EN 60529, Degrees of protection provided by enclosures (IP Code).
- .2 BS EN 62262, Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code).
- .3 ANSI/NEMA 250, Enclosures for Electrical Equipment (1,000 Volts Maximum)
- .4 IEEE 802.1X, Port-Based Network Access Control
- .5 IEEE 802.3, IEEE Standard for Ethernet
- .6 IEC/EN 60825-1, Safety of laser products

1.3 Submittal

- .1 Submit the finalized Design Data for review to owner's Representative in AutoCAD or PDF editable format prior to any work being done.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers for VMS:

- .1 Avigilon Unity Video
- .2 Or approved equivalent

2.2 Acceptable Manufacturers for Cameras:

- .1 Avigilon – Motorola Solutions
- .2 Or approved equivalent

2.3 Design and Performance Requirement

- .1 System Requirement:
 - .1 The system shall be an IP based, non-proprietary, redundant, enterprise solution supporting IP and IP megapixel camera technologies. The system shall be a complete solution that is scalable from the existing scope of this project to several thousand cameras which can be added on a unit-by-unit basis. This future expansion capacity shall not require significant replacement or upgrading of hardware or equipment provided as part of the initial solution.
 - .2 All system testing shall follow the testing, commissioning and acceptance process outlined in Section 28 05 00 Common Work Results for Electronic Safety and Security.

- .3 Provide detailed wiring diagrams. Finalize the wiring diagrams to meet any site-specific conditions and provide a fully functional system. See Section 28 05 00 Common Work Results for Electronic Safety and Security.
- .4 Provide and include all costs as a part of their solution for a Specialty Engineer to be present at all testing and commissioning of the system. Provide the Specialty Engineer access to all points of the installation. Provide all test and access equipment required for the inspection.
- .2 System Description:
 - .1 The VSS shall consist of field and termination equipment necessary to provide a fully automated system.
 - .2 The VSS shall be designed on a distributed processing architecture employing remote cameras and operator workstations connected to a redundant central server and storage solution.
 - .3 Connect all security cameras to centrally located network switches located in communications rooms.
 - .4 The system shall be configured to a maximum of 75% of its device and recording capacity.
 - .5 The field device to Telecom Room allocation shall be identified by contractor. Ensure that such allocations do not cause cable lengths to exceed a distance of ninety (90) meters. In the case of exterior remote locations fibre optic connectivity shall be employed.
 - .6 Location of additional video surveillance cameras shall be based on operational requirements of the Facility and subject to review by owner.
 - .7 All cameras shall be placed and provided in sufficient configurations and quantities to obtain the level of detail required in the output specifications.
 - .8 The VSS shall provide all integrated functionality as described in the drawings and this specification. This includes integration with the Access Control, Intercom and ICAT Systems. All integration shall be based on IP protocols and included as part of the standard product offering by the system supplier.
 - .9 All video streams from cameras shall be digitally encoded using H.264 or latest compatible compression formats for simultaneous monitoring and recording in real time.
 - .10 Each camera's bit rate, frame rate and resolution shall be set independently from other cameras in the system and altering these settings shall not affect the recording and display settings of other cameras.
 - .11 The system shall not require proprietary recording hardware, hardware multiplexers or time-division technology for video recording and monitoring.
 - .12 The system client and server applications shall be based on a true open architecture that shall allow for use of non-proprietary PC storage hardware that shall not limit the storage capacity and shall allow for incremental upgrades of recording capacity.

- .13 The system client and server applications shall support a minimum of thirty (30) simultaneous use VSS keyboards where each keyboard can operate the entire set of cameras throughout the system, including cameras of various suppliers' brands.
- .14 The system shall digitally sign recorded video by way of watermarking to prevent image tampering and to confirm image integrity.
- .15 The system server and client software applications shall be able to operate on separate networks.
- .16 The system shall have the capability of simultaneous live viewing and recording of individual cameras at different frame rates and resolutions.
- .17 Full "Fail Over" server redundancy is a mandatory requirement of this specification. It is intended that all system configuration and user authentication parameters be contained on a minimum of two (2) fully redundant mirrored system servers with real time replication be supplied and installed separately in MCR and ACR. In no case shall both servers be installed in the same room.
- .18 The VSS shall incorporate SMART diagnostics that monitor the internal operation of a drive (including external storage drives) and provide early warning notification to guard room operators for many types of potential problems. This shall allow for the drive to be repaired or replaced before any data is lost or damaged.
- .19 The VSS shall utilize a redundant centralized storage topology. All video system storage shall be located in the Main IT Room.
- .20 The VSS shall allow authorized users to save video to a standard recordable DVD. The option to include the player software on the DVD shall be available so that no additional software needs to be purchased.
- .21 The VMS shall incorporate full programming and prioritized control between users and PTZ domes.
- .3 Monitoring Locations:
 - .1 System monitoring shall be as defined in the drawings and specifications.
 - .2 System monitoring shall also be provided via web browser accessible from any workstation on the converged network. Access shall require a valid user ID and password.
 - .3 The system shall be capable of operating even in the event that the system management server is unavailable.
 - .4 Following a power failure and the restoration of main or backup power, the VSS shall revert automatically, within 3.5 minutes, to normal service status without the need for operator intervention. The system shall restart in the same state as existed before the power interruption with no loss of functionality or transaction data.
- .4 Communications Rooms:

- .1 Provide cable troughs, conduit, and emergency power circuits for equipment configurations. Cable troughs shall be grounded to earth ground.
- .2 All video termination equipment with the possible exception of non-PoE camera power supplies shall be rack mounted in equipment cabinets.
- .3 Keep all video equipment clean and free of dust at all times during the installation.
- .5 Power:
 - .1 All Source 120VAC power for security equipment shall be Emergency power with UPS backup.
 - .2 Provide lockable, hinged covered, terminal cabinets for all power supplies, transformers, and power distribution terminal strips. Provide all conduit and wiring from the 120 VAC facilities to the terminal cabinets.
 - .3 Provide protection against surges, spikes, noise, and other line problems for all system equipment and their components. In addition to generator support, all power sources shall be equipped with uninterrupted power supply capable of supporting all attached equipment for a period of sixty (60) minutes.
 - .4 All equipment and system components which are powered by more than 48 volts AC or DC shall be ULC listed for safety. This includes equipment or system components classified as non-power limited.
 - .5 All video system power supplies shall have battery backup and shall be monitored, by the ACS, for line failure on a dedicated monitoring input point. Therefore, when an AC line fails, a unique alarm condition shall be caused.
- .6 Network:
 - .1 Ensure all IP addressing schemes used on the converged network are coordinated and Reviewed by owner.
- .7 Interface with Other Systems:
 - .1 ACS: Refer to Section 28 05 00 Common Work Results for Electronic Safety and Security along with Div 27 specifications.
 - .2 SIS: Refer to Section 28 05 00 Common Work Results for Electronic Safety and Security along with Div 27 specifications.
 - .3 DPAS: Refer to Section 28 05 00 Common Work Results for Electronic Safety and Security along with Div 27 specifications.
- .8 Building Wires:
 - .1 Be fully responsible for the ultimate design and implementation of the system topology (physical and logical) best suited for the project, given identified and recognized physical infrastructure and constraints.

2.4 Field Devices

- .1 Interior Fixed Dome Network Camera (Type – 01):
 - .1 For indoor public/ front of house applications.

- .2 Be capable of being powered via POE and connected via an RJ-45 connector.
- .3 Image sensor progressive RGB CMOS sensor.
- .4 Fixed IRIS lens 2.8mm.
- .5 Light sensitivity performance at minimum 0.5 lx (color) and light transfer capability F2 maximum.
- .6 HDTV performance 1080P, 2MP resolution.
- .7 Designed for quick and flexible installations. Wall, ceiling, or pendant mounts.
- .8 Vandal resistant, IP42 water and dust resistant. IK08 impact resistant.
- .9 Operating temperature: 0°C to 45°C.
- .10 Multiple video streaming and controllable frame rate and band width.
- .11 Image rotation 0°, 90°, 180°, 270° including Corridor format for vertically oriented video streams for areas such as corridors, hallways, etc.
- .12 Enable for image setting: compression, color, brightness, sharpness, contrast, white balance, exposure control, wide dynamic range, text and image overlay, mirroring of images, and privacy mask.
- .13 Enable installation of intelligent video application such as people counting, and enable installation for third party applications.
- .14 IP address filtering, https encryption with password protection.
- .15 Video motion detection and active tampering alarm.
- .16 Minimum 512 MB RAM and 256 MB flash memory.
- .2 Fisheye Lens Network Camera (Type – 02):
 - .1 For corridor intersection.
 - .2 Shall be powered by the Security LAN POE or POE+ and connected via an RJ-45 connector. Power Supply Equipment (PSE) is required, subject to the camera meeting the maximum POE power requirements and the minimum ambient operating temperature requirements.
 - .3 Image sensor progressive RGB CMOS.
 - .4 Varifocal, remote focus and zoom, P-IRIS control, IR corrected lens 3.5-10mm.
 - .5 Sensitivity performance at minimum 0.18 lx (color) 0.04 lx (black and white) and light transfer capability F1.7 maximum.
 - .6 Fixed dome with HDTV performance 1080P, 5MP resolution.
 - .7 Multiple video streaming and controllable frame rate and band width.
 - .8 Enable for image setting: compression, color, brightness, sharpness, contrast, white balance, exposure control, exposure zones, forensic WDR, text and image overlay, mirroring of images, privacy mask, and fine tuning of low light behavior.
 - .9 Image rotation 0°, 90°, 180°, 270° including Corridor format.
 - .10 IP address filtering, https encryption with password protection.

- .11 Video motion detection and active tampering alarm. Enable installation of digital auto tracking, and third party application.
- .12 Vandal and IK10 impact resistant. Weather-proof has IP66 and Nema 4X rating.
- .13 Operate within the temperature range of -40°C to +55°C in a temperature controlled enclosure. Provide ventilation and/or heating elements either integral or within camera housing to achieve operational temperature.
- .14 Minimum 1 GB Ram and 512 MB flash memory.

2.5 Display And Control Equipment

- .1 Central Management Servers:
 - .1 The computer hardware described in this section shall be used to run the central management system server software used for storage of the VSS. This equipment as well as operator workstation PC will be supplied by owner. contractor shall submit requirements for management server and workstation PCs to owner to ensure suitability with system supplier's functional requirements and so they can be procured and deployed in alignment with contractor's schedule.
 - .2 Specifications for these servers shall be in compliance with the software developers recommended requirements for all software applications that are installed on the system. Servers provided shall match at minimum the Supplier's minimum recommended specifications at time of procurement, in addition to the minimums noted below.
 - .3 Operating System:
 - .1 Microsoft Windows Enterprise Server (latest version) or approved equivalent.
 - .4 Database:
 - .1 SQL Server (latest version) or approved equivalent.
 - .5 Hard Disk Drive:
 - .1 Hot swappable, 250 GB or more. It shall be possible to expand this capacity by upgrading the fixed disk or through additional disk drives.
 - .6 Redundancy:
 - .1 Minimum of RAID 1 (operating system), RAID 5 (storage array).
 - .7 Accelerated video card
 - .8 Dual Network Interface Card:
 - .1 10/100/1000 Mbps Ethernet Fast Ethernet Controller, IEEE Compliance - 802.3, 802.3u, 802.3x, 802.3z, Compatible with Cat 6 cabling.
 - .9 DVD:
 - .1 DVD+/-RW drive
- .2 Keyboard Controller

- .1 The control unit joystick shall include integral camera zoom lens control, allowing one hand operation.
- .2 The controller shall provide, but not be limited to, selection of the following remote camera site functions:
 - .1 Joystick control of pan/tilt/zoom
 - .2 Focus, and iris lens control
 - .3 Auto pan, auto tour
 - .4 Selection of up to ninety-nine (99) pre-positioned scenes per camera.
- .3 Mechanical Specifications
 - .1 Controls:
 - .1 Momentary push buttons.
 - .2 Pan/tilt/zoom joystick.
 - .3 Control unit shall be supplied as a desktop model.
 - .2 Operating Temperature: 0°C - +40°C.
 - .3 Humidity: 10 to 80% relative, non-condensing
- .3 Video System Storage
 - .1 Supply, install, and configure network storage devices.
 - .2 Recorders and associated storage shall be deployed to data center rooms only. Include all current software, firmware and licenses.
 - .3 The storage system shall support storage of video images from cameras that terminate in remote communications room plus spare capacity and event storage capacity as required in specifications.
 - .1 Shall support recording parameters as such:
 - .1 The Video Surveillance system including the Video Surveillance system server and network video recorders shall be sized, equipped to record all video streams from all Video Surveillance cameras continuously at:
 - .2 Frames Per Second: 20
 - .3 Resolution: 4MP
 - .4 Compression: H.264 or H.265 (Good Quality)
 - .5 Recording: 100%, 24 hours per day 7 days per week
 - .6 Retention Days: 31
 - .7 Image Complexity: 50 - Average
 - .8 Motion %: 50 - Medium
 - .9 Spare capacity: 30%

- .2 Support record and playback of H.264 video streams to all monitoring locations from any or all cameras simultaneously.
- .3 Be IP attached via 10GBaseT PoE+ Ethernet using commonly available networking configurations and equipment.
- .4 Conform to and be deployable in industry standard 19" rack configurations. Mounting of equipment on shelves is not acceptable.
- .5 Storage system shall support high availability with no single point of failure causing loss of data or interrupting access to data:
 - .1 Protect data for up to three (3) simultaneous disk failures with no loss of data or loss of access to data.
 - .2 Protect against loss of a storage appliance or controller with no loss of data or loss of access to data.
 - .3 Protect against loss of a networking path between servers and storage, including network interface card, cables and switches, with the ability to dynamically reroute IO activity to an alternate network path.
- .6 Support dynamic replacement of hardware components without interrupting access to data:
 - .1 Support the ability to replace disk drives without the need to interrupt data access.
 - .2 Provide redundant power supplies to support the ability to replace power supplies without the need to interrupt data access.
 - .3 Support the ability to replace fan modules without the need to interrupt data access.
 - .4 Support the ability to replace entire appliances without the need to interrupt data access.
 - .5 Support the ability to replace network switches without the need to interrupt data access.
- .7 Support dynamic management features to insure continuous data access:
 - .1 Be expandable by the addition of disk capacity without the need to interrupt data access.
 - .2 Be expandable by the addition of processing capacity without the need to interrupt data access.
 - .3 Be expandable by the addition of network bandwidth without the need to interrupt data access.
- .8 Be scalable in capacity to four (4) petabytes.
- .9 Provide capacity and performance usage statistics.
- .10 Allow dynamic configuration of volumes.
- .11 Provide administrator security controls.

- .12 Detect controller and drive failures and shall export and annunciate / notify the monitoring locations defined in the OS, via the ACS client application. The system shall also provide a local audible alarm.
- .4 Include SNMP management support.
- .4 Rack Mounting:
 - .1 All equipment to be located within termination equipment cabinets shall be rack mounted.
 - .2 Equipment to be security fastened in racks with supplier supplied or approved rails and mounting fasteners.
- .5 Information Backup/Retrieval:
 - .1 The system server(s) shall be capable of transferring all programmed data and transactional history to an appropriate archive storage media. All programmed data shall be restorable from the back-up media in case of system hardware failure.
- .6 Communication Rates:
 - .1 The system shall be capable of supporting 1GB Ethernet communications rates to client workstations.
- .7 Printers:
 - .1 The system server shall support report printers. The report printers shall be network printers connected to the Security local area network.
- .8 Communication Ports:
 - .1 Network Ports:
 - .1 The system server shall support the use of Ethernet networks as the communications path between the server and end devices, and other systems for the purpose of integration. This communications path shall be the same network used for communications between the system server and the operator workstations. The communications between the system server and the field devices shall be encapsulated in a TCP/IP network/transport layer.
 - .2 Port Name:
 - .1 Each communications port shall be addressed with the system by a unique name.
 - .3 Port Description:
 - .1 The system server shall provide the ability to add a communication port description to each port configuration. There shall be no limit to the amount of text that can be used to describe the communications port.
 - .4 On-line/Off-line:
 - .1 The system server shall allow the operator to put a communications port on-line or off-line. If the communications port is placed off-line, the system server shall not use the port to communicate to field device configured on

that port. If the communications port is put on-line, the system server shall use the port to communicate to field devices configured on that port.

.5 Communications Failure:

- .1 If the communications port is on a network device, such as a terminal server, the system server shall indicate if there is a loss of communications to that network address. All field units connected to that network address should also be reported as being in communications failure.
- .2 To allow for network delays, the system server shall allow the system administrator to define a wait time before annunciation of a communications failure.
- .3 The system server shall provide the administrator the ability to set a reconnect retry period. This is the time period the system shall wait before attempting to re-establish communications with a network port which is in communications failure.
- .4 Configuration of the remote communications port characteristics, i.e. baud rate, parity, error-checking etc. shall be done either on the network device or through network management tools. The configuration is not required to be executed by the central management system.
- .5 IP Address:
 - .1 For communications ports on a network device, the system server shall allow the operator to define the IP address of the device, as well as the local port address, to which the remote field devices are connected.

.9 RAID

- .1 The system shall support a RAID that provide high performance and fault tolerance. The RAID array shall appear to the System Server as a single storage unit or as multiple logical units.
- .2 RAID 5:
 - .1 The System Server shall support the use of RAID level 5. RAID level 5 provides complete data redundancy.

.10 Redundancy

- .1 Through the use of third party software and associated hardware, the system server shall support a second system server for redundant capability. During normal operation, data shall be written to either server and shall be mirrored to its counterpart in a bi-directional mirroring process.
- .2 If a failure is detected, it shall be verified across both the network and the mirrored data links through the ESB. When the failure has been verified, the surviving server shall assume the functions and identities of the failed server without having to sacrifice its own identities or functions. Applications originally running on the failed server are restarted on the surviving server.
- .3 Shall send alerts via SMS or email.

2.6 Technical Requirements – Software

.1 General

- .1 Provide all required hardware and software required to allow for complete system installation and in compliance with the scope outlined in the specifications and drawings.
- .2 Supply the most recent version of software that supports full integration and functionality as described in the specifications and drawings.
- .3 The System shall be an IP based solution which shall include the following functions:
 - .1 Live viewing
 - .2 Recording & playback
 - .3 Support of system integration as defined in the PSOS.
 - .4 Interactive maps
 - .5 Centralized administration
 - .1 Device discovery
 - .2 User groups
 - .3 Multiple administrator users
 - .4 System diagnostics
- .4 Virtual Matrix:
 - .1 Enable CCTV keyboard control similar to matrix switcher.
- .5 Analytics tools such as:
 - .1 Video motion detection
 - .2 Directional video motion detection
 - .3 Abandoned object detection
 - .4 Virtual tripwire
 - .5 Shape-based detection
 - .6 Theft detection
- .6 Remote Video Management:
 - .1 The system shall work with a single remote software program that enables video management from a remote computer.
- .7 Password Protection:
 - .1 To limit user access to the system, password log-on protection for up to sixty-four (64) users shall be provided. To increase user flexibility or restriction, eight (8) programmable levels of priority shall be provided for each user's password.
- .8 On-screen Monitor Display:

- .1 Each system output shall be configured to provide on-screen display of site number and title, video input number and title, time, date, camera and monitor status.
- .2 The monitor display shall show the keyboard number or user number in situations where a higher priority keyboard or user has control of a camera or has locked a camera.
- .9 Time Synchronization:
 - .1 Synchronize all video system devices to IP ethernet NTP for integration with other network devices.
- .10 Communication Ports:
 - .1 The system shall be configured to provide external connection to computers, printers, alarm interface units, recorder interface units, and additional system control keyboards.
- .11 Macros:
 - .1 Program and configure macro commands per keyboard as required.
- .12 Alarms:
 - .1 The matrix switcher/controller shall be configured to provide e-mail messaging of specific alarms and diagnostic alarms when activated.
- .13 Activity Logging:
 - .1 The system shall have activity logging and reporting to an IP network PC used for setup and file storage.
- .14 Provide all programming and configuration of tours, salvos and camera patterns as required by owner during User Group Meetings.
- .15 Recorder Control:
 - .1 The system shall provide for remote management to directly control important video management system functions such as play, stop, pause, record, rewind, and fast-forward.
- .2 Server Applications:
 - .1 Windows Server latest version, or as specified by VMS manufacturer.
 - .2 All compatible necessary hardware/software drivers
 - .3 RAID management and diagnostics
 - .4 DVDRW/CDRW management software for video and data back-ups.
 - .5 Lightweight antivirus software ideal for storage intensive servers
- .3 VMS:
 - .1 The VMS shall have the capability of viewing live and recorded video of all field cameras from all sites simultaneously.
 - .2 As a minimum the VMS shall be capable of quick analysis of thousands of recordings using events triggering, video motion detection, time, date and

- camera search criteria, saving valuable incident search time and the ability to playback recordings from remote sites without interrupting current recordings.
- .3 NVR recordings shall have the ability to be accessed simultaneously locally or remotely using the VMS client software by any number of users. It shall be possible to assign user rights and privileges to each user to restrict access to authorized users.
- .4 NVR management and configuration shall be performed using a client application that forms part of the digital VMS.
- .5 NVR recorded video shall not have the ability to be altered, ensuring the audit trail is intact for evidential purposes. Recordings exported from the system shall be protected by a watermark and a digital signature.
- .6 VMS shall work with other 3rd party IP components, e.g., cameras, monitors, keyboards and PTZ units. The system shall enable users to control PTZ cameras when viewing live video. In addition, administrators can have the capability of configuring custom commands and pre-sets for each PTZ camera and also set user priorities and privileges by preventing other users from controlling it.
- .7 PTZ cameras shall be controlled by using an external joystick, or directly in the video pane from the VMS using a mouse. The camera to be easily panned and tilted in different directions at variable speeds by simply moving the mouse and zoomed by clicking.
- .8 The VMS operator shall have the ability select any of the encoded camera video streams, live or recorded and manually link to a display monitor.
- .9 The VMS shall support motion detect, binary and video loss alarms and to also trigger relays and send IP triggers when an alarm occurs.
- .10 The ability to playback simultaneously recordings from a minimum of eight (8) cameras.
- .11 The VMS Shall come equipped with an interactive facility and site mapping graphical user interface to allow for all site locations including camera and alarm positions accurately plotted.
- .12 The client monitoring application shall allow level access control per user to every camera.
- .13 Several users shall have the ability to simultaneously view, manage and record across the network from any point on the network.
- .14 The video management system software shall provide the ability to cut video streams from remote client workstation at any time.
- .4 VMS Client Application:
 - .1 The VMS client application shall consist of but not be limited to the following tasks:
 - .1 Live camera viewing,
 - .2 Live PTZ control

- .3 NVR playback
- .4 Alarm event processing,
- .5 Device configuration,
- .6 System administration,
- .7 Video and event archiving,
- .8 Mapping
- .9 Event reporting.
- .2 The client application shall perform all the necessary standard monitoring functions simultaneously without interfering with any of the system server operations
- .3 The client application shall support any form of IP network connectivity, including LAN, WAN, VPN, Internet, and WLAN technologies.
- .4 All client applications shall support IP Multicast and Unicast (UDP) video streaming.
- .5 Client application shall provide an authentication mechanism, which verifies the validity of the user.
- .6 Each workstation shall be able to use a CCTV keyboard controller or PC keyboard/mouse that can control the entire set of cameras throughout the system, even if the system consists of motorized cameras produced by different Suppliers.
- .7 The client applications shall allow for multiple instances to run simultaneously, by one or multiple users on separate workstations.
- .8 The client applications shall provide administrators with the ability to block video streams to lower-level users.
- .9 The client application graphical user interface shall include the following tasks and functions:
- .10 Live Viewing:
 - .1 Display live video from any encoded camera on the workstation video panes.
 - .2 Display live video from any encoded camera on external monitors.
 - .3 Capability to view a set of cameras in succession.
 - .4 Perform camera to monitor call up, PTZ, focus, edit and enable pre-sets and perform customized actions using internal or external keyboard controller.
 - .5 Record live video and take snapshots of images.
 - .6 Performance
 - .7 The live viewer shall allow live viewing of video streams.

- .8 Multiple users shall be able to view the same camera sequence simultaneously; users are able to pause the sequence without affecting other viewers.
- .9 Shall enable live monitoring of one (1) to sixteen (16) video streams simultaneously on a single monitor and one (1) to thirty-two (32) video streams simultaneously on a dual monitor.
- .10 Shall display all cameras, monitors and camera sequences in the system.
- .11 Shall allow operators to control including pause, play, skip forwards, and skip backwards camera sequences.
- .12 Shall have the option to perform drag and drop functions to an external monitor (decoder) or workstation to view a camera.
- .13 The operator shall be able to control camera pan-tilt-zoom, iris, focus, call pre-sets and configure integrated PTZ dome features by using an external or internal application keyboard controller.
- .14 Each operator shall be assigned a PTZ priority to allow a prioritization between operators on who has control over a camera.
- .15 Users shall be able to take snapshots of live video feeds in the live viewer and be able to save or print the snapshots.
- .16 Users shall be able to control PTZ functions with a CCTV style joystick using the workstation.
- .17 Shall have the ability to view minimum of sixteen (16) simultaneous live video streams from the DVMS client application in two (2) windows using dual head monitors. Live and recorded video to be viewed at the same time.
- .18 The operator shall be able to start/stop recording on any camera in the system.
- .19 The video management system software shall provide the ability for guard room operators to stop video streams from displaying on a specific or group of remote client workstation at any time via an operator initiated command. Should the selected client workstation(s) be viewing the video stream at the time a guard room operator activates this feature, the remote client workstation(s) shall stop displaying the selected video stream, and automatically change the display to a black screen.
- .11 NVR Playback and Video Event Archiving:
 - .1 Search through past recorded footage.
 - .2 Playback recordings.
 - .3 Save snapshots and recordings to file as evidence on workstation and export to DVD.
 - .4 View thumbnails of a fixed number of images, distributed at equal intervals across the current range of the timeline.
 - .5 Export and protect recordings

- .6 Find motion in sections of recorded footage.
- .7 View a thumbnail image of each time that the motion profile in the current timeline range exceeds the threshold.
- .8 Shall allow for multiple recording schedules to be assigned to a single camera. Each schedule shall have the capability to vary parameters such as, video quality, recording mode and time and date settings.
- .9 The NVR shall have the ability to dynamically change recording quality settings on alarm and events.
- .10 The NVR shall keep a log and compile statistics on disk space usage.
- .11 The NVR shall have the capacity to schedule backups of the video archives, with associated database events to an appropriate device.
- .12 The NVR shall keep log of the system events for maintenance purposes.
- .13 Shall support video playback of any time span.
- .14 Shall enable operators to choose from a number of possible camera display patterns ranging from one (1) tile to sixteen (16) tiles patterns.
- .15 Shall allow the operator to select between synchronous playbacks of all selected video streams.
- .16 Shall allow the operator to simultaneously view the same camera in multiple tiles at different time intervals.
- .17 Shall be able to query archived video from one or multiple archived video servers using various search criteria, including but not limited to, time, date, camera, site and past alarms.
- .18 Shall allow operators to define an area of the video field in which to search for motion as well as define the amount of motion that shall trigger search results.
- .19 Shall allow operators to validate if a digitally signed video sequence has been tampered with or not.
- .20 Shall provide still image export to JPEG and BMP format with date and time stamp on the image.
- .21 Shall provide tools to export video sequences in standard video formats, such as AVI and ASF.
- .22 Shall provide tools to export video sequences and any required video player on DVD.
- .23 Shall support playback of archived video to NTSC system monitors.
- .12 Alarm Processing:
 - .1 View and acknowledge all alarms that have occurred on sites.
 - .2 Respond to alarms as specified by an administrator
 - .3 Play back recordings associated with alarms.
 - .4 View live video of the scene where an alarm has occurred.

- .5 View a thumbnail image for each alarm in the current timeline range.
- .6 Display a map of the site where an alarm has occurred
- .7 The VMS shall receive all incoming events (motion detection, IP trigger) in the system and take appropriate actions based on user-defined event/action relationships.
- .8 The VMS shall receive and log all alarm events and system generated events.
- .9 The VMS shall have the capability to automatically execute any necessary actions in response to generated events.
- .10 The VMS shall use an event and timestamp database for advanced search of video archives.
- .11 The VMS shall provide the functionality of storing of video streams based on triggering events such as, digital motion detection, digital input activation or on a schedule.
- .12 Each entry in a sequence shall have the capacity to trigger camera pre-sets, patterns or auxiliaries.
- .13 The client application shall have advanced alarm management, which shall have the ability to assign alarms and procedures to specific users or user.
- .13 Mapping:
 - .1 Client application shall support Mapping functionality, where digital maps are used to represent the physical location of cameras, alarms, NVR's and other devices throughout the entire system.
 - .2 Operators shall have the ability to double click on a camera map link to display live video to be displayed on the workstation on the first available monitor.
 - .3 Maps to automatically display alarm activity of a particular site.
 - .4 Administrators shall have the ability to create the following:
 - .1 Creating multiple maps of sites and linking sub maps to sites.
 - .2 Adding and modifying Alarm sources to maps
 - .3 Adding and modifying cameras to maps, including editable field of view illustrations
 - .4 Dual workstation display capabilities
 - .5 System administration
- .14 Provide as part of their solution all associated cost for the supply, install, configuration, and coordination of the quantity of client licenses and workstations required by OS.
- .15 Black Screen:

- .1 For monitoring of video at the primary monitoring location defined in the OS, the system shall be configured as a black screen system such that incoming alarms shall be displayed on a block (group) of monitors with which they are associated. The first incoming alarm is displayed on the first (lowest numbered) monitor of the block. The second alarm is displayed on the next lowest numbered monitor of the block, and so on. When all monitors in a given block are displaying alarm video signals, all subsequent alarms shall be placed in sequence and shall cycle continuously until each is cleared. Each alarm shall be displayed for a pre-programmed dwell time before it is succeeded by the next received alarm. When the last alarm on a given monitor within a group is cleared, a black screen shall automatically appear indicating there are no further alarms to be displayed.
- .2 During alarm response, the system shall provide programming for automatic call-up of a camera pre-set and provide on-screen text indicating the occurrence of an alarm.

PART 3 - EXECUTION

3.1 Installation

- .1 Install products in accordance with product manufacturer's written instructions for type and use.

END OF SECTION

- 1 General
 - 1.1 **SUBMITTALS**
 - .1 Submit shop drawings for products specified in this Section.
 - 1.2 **SOFTWARE NOMENCLATURE REPROGRAMMING**
 - .1 Include additional costs for system manufacturer to make necessary on site final changes to applicable system/equipment software. Make such changes after successful testing and verification of systems, but prior to turn over to Owner. After successful final verification of work, confirm and obtain approval of final nomenclature in writing from Owner and Consultant. Software revisions to incorporate final room names/area names/building names and equipment identification.
- 2 Products
 - 2.1 **EXISTING FIRE ALARM SYSTEM WORK - GENERAL**
 - .1 Existing fire alarm system is by Edwards EST series. Modify existing fire alarm system to suit the Project. Engage base building fire alarm contractor to provide and perform required system work. Work required to be provided on existing system to include but not be limited to:
 - .1 necessary update work for existing system control panel, graphic command centre (GCC) and annunciator to accommodate additional transponders, additional devices and zones, replacement of devices, reworking of existing zones and circuits, and integration of additional system serving additional areas of Project;
 - .2 provision of additional transponders to replace existing transponders being deleted;
 - .3 provision of transponder/control panel at existing CACF, to accommodate system changes done by this project;
 - .4 provision of additional initiating devices (pull stations, heat/smoke/flame detectors, etc.), and alarm indicating devices (speakers, horns, strobes, etc.);
 - .5 provision of additional interfaces and interconnections to auxiliary building systems;
 - .6 ancillary devices such as relays, power supplies, etc. to suit devices mentioned above;
 - .7 review of existing battery backup capacity and amplifiers (as applicable) and increasing capacities to accommodate additional device loading and to meet applicable governing local code requirements;
 - .8 additional wiring in conduit and/or fire rated cables;
 - .9 re-programme system to suit renovations work;
 - .10 update fire alarm passive graphics.
 - .2 Typically, additional devices to be added to existing system shall be ULC listed and labelled same as or compatible with existing. System components and work in conjunction with system installation to meet specific application requirements of local governing authorities, codes, standards, and regulations.

- .3 Verify with existing fire alarm system manufacturer during Bid period, exact requirements needed to provide renovation work. If necessary, visit site with manufacturer to review existing conditions. Confirm and coordinate exact work responsibilities with system vendor. Items of clarification or proposed revisions to Bid Documents must be reviewed with Consultant during Bid Period.
- .4 Include costs for manufacturer's authorized representative to perform control panel/transponder work and to reprogram system software to accommodate renovation work. Provide additional zone modules as required and additional batteries as required to supply back-up battery capacity to the additional components.

2.2 DEVICES

- .1 Exact type of device to be used in each area of installation to be as recommended by system manufacturer to suit specific applications and to be approved for such use as per ULC standards. Devices in non-climatic controlled areas to be weatherproof, corrosion resistant and ULC listed for use in below freezing temperatures. System manufacturer to be responsible for ensuring compliance with these requirements.
- .2 Additional smoke detectors and heat detectors: to be of type and rating to suit specific application as per existing system manufacturer's recommendations.
- .3 Addressable modules as required for connection of additional devices.
- .4 Ancillary devices as required to complete system.

2.3 ADDRESSABLE MODULES

- .1 Addressable modules to be used for monitoring of water flow, valve tamper, non-addressable detectors, air sampling smoke detectors, and for control of fans or dampers that require shutdown or manual control in an alarm condition.
- .2 Addressable modules to monitor any N/O contact device and be capable of powering
- .3 2-wire smoke detectors. Addressable modules to communicate zone's status (normal, alarm, trouble) to transponder. Addressable modules zone address to be set at time of installation via a dip switch package.
- .4 Addressable modules to be able to provide supervised or non-supervised control of any control function. Addressable modules to communicate zone's status (normal, trouble) to transponder. Each addressable modules to provide a double pole double throw relay for switching loads of up to 120 VAC. Each common leg of relay to be equipped with a replaceable fuse sized as required.

2.4 PULL STATIONS

- .1 Pull stations to be addressable, single action, non-coded, 2-stage, semi-flush mounted type. Pull stations to be key locked and have 2-sets of sealed N/O contacts. One (1) contact is to activate when handle is pulled down, activating a first stage alarm. Second contact is operated by means of a key switch, which activates second stage alarm. Stations to be complete with auxiliary contacts to connect to other building systems, such as to release doors upon 2nd stage alarm activation. Confirm exact sequence of operation with Consultant prior to programming. Set station's address at time of installation.

- .2 Stations located in areas of high abuse or where designated to be complete with guard, to be equipped with STI type, ULC listed and labelled, hinged clear Lexan cover and which to include an integral battery operated alarm if required by code or local fire authority. Include for provision of a quantity of 5 covers to be installed in locations defined by Owner at site.

2.5 DETECTORS AND BASES

- .1 Addressable smoke and heat detector heads as specified below to lock onto their bases. Same base to be compatible for both smoke and thermal detectors. Upon removal of head, a trouble signal to be transmitted to transponder. Detector's address to be set at time of installation.
- .2 Where required provide an additional alarm relay (Form C, SPDT), normally open contact, for auxiliary functions.
- .3 Each detector to contain a LED that flashes each time it is scanned by transponder. When transponder determines that a detector is in alarm or a trouble condition, transponder to command LED on that 'detector' to turn on steady indicating abnormal condition.
- .4 Each detector to be scanned by transponder for its type identification to prevent inadvertent substitution of another detector type. Transponder to operate with installed device but to initiate a 'Wrong Device' trouble condition until proper type is installed or programmed detector type is changed.
- .5 Detector bases include wiring terminals that are accessible to "room side" after mounting to a standard 4" (100 mm) octagon box.
- .6 Various types of bases to be provided to suit each respective application, which is to be confirmed with system manufacturer. Types include:
 - .1 standard type equipped with wiring terminals, for mounting to a standard 4" (100 mm) octagon box and complete with tamper-resistant mechanism to prevent unauthorized removal of unit head from base;
 - .2 relay type that is same as standard type but complete with auxiliary relay;
 - .3 audible type includes an audible alarm sounder;
 - .4 isolator type with line fault isolator.

2.6 PHOTOELECTRIC SMOKE DETECTORS

- .1 Multi-sensor smoke detector to be addressable photo-electric and thermal technology types.
- .2 Detector's microprocessor measures and analyses signals and filters out signal patterns not typical for fires, thus limiting false alarms. microprocessor also performs:
 - .1 self-diagnostics and history logging, with results stored in non-volatile memory;
 - .2 automatic device mapping with supervision of each device location;
 - .3 identification of dirty or defective detectors;
 - .4 stand-alone operation if communications fail between it and main system CPU;
 - .5 on board intelligence which limits information required to be sent to main CPU.
 - .6 Sensitivity range of each detector set in transponder to be from

- .7 0.67-3.7% smoke obscuration. Each detector to have minimum five different programmable sensitivity levels within this range - 1.0, 2.0, 2.5, 3.0, and 3.5%.
- .3 Detectors feature:
 - .1 a low profile design and ULC Listed for both ceiling and wall mount applications;
 - .2 tamper resistant features;
 - .3 electronic addressing;
 - .4 electronics immune from false alarms caused by EMI and RFI;
 - .5 insect screen;
 - .6 environmental compensation;
 - .7 automatic day/night sensitivity adjustment;
 - .8 RED/GREEN status LED indicators.
- .4 Detectors to be equipped with a dust-bag, which is removed at time of verification, to prevent dust and dirt entering smoke chamber during construction.
- .5 Detector in-patient rooms to be complete with auxiliary contacts for connection to amber lamps of nurse call dome lights.

2.7 AUDIBLE/VISUAL DEVICES

- .1 Devices include speaker, strobes and combination units. Devices to mount on wall back boxes. Back boxes to be supplied by system manufacturer to suit specific devices and type of installation. Finish colours to match existing devices on site.
- .2 For finished areas wall mounting: speakers and speaker/strobe combination units with following features:
 - .1 compact low profile housing;
 - .2 consisting of cone speaker and synchronized strobe;
 - .3 102 mm (4") mylar cone speaker with sealed back construction;
 - .4 speaker frequency response: 250 to 5,000 Hz;
 - .5 DC blocking capacitor for audio circuit supervision;
 - .6 25/70 volt operation with ¼, ½, 1 or 2 watt taps;
 - .7 sound output to 90 dbA @ 3m (10') tapped @ 2 watts;
 - .8 integral strobe with Lexan lens; illumination range from 15 cd to 110 cd;
 - .9 field-configurable temporal strobe output where required by local governing fire authority;
 - .10 red plastic housing with "FIRE" marking on housing;
 - .11 suitable for mounting on surface or flush back boxes.
- .3 Stand alone strobes to be similar to features of combination units specified above but only with strobe features.
- .4 In finished areas, devices to mount to a 100 mm (4") square, 60 mm (2-1/8") deep, back box. Where devices are to be surface mounted, provide a red finished surface back box with no knockouts.
- .5 Devices mounted exterior to be complete with "weatherproof" box.

2.8 **END-OF-LINE RESISTORS**

- .1 End-of-line resistors for standard alarm and signalling circuits to be sized to ensure correct supervisory current flows in each circuit.
- .2 End-of-line resistors to be mounted on a stainless steel plate for mounting on a standard single gang box and bear ULC label.

2.9 **ISOLATORS**

- .1 Isolators to be provided in accordance with code requirements and installed as per system manufacturer's requirements to isolate/monitor zones, loops, group of devices within building and between buildings.

2.10 **WIRING**

- .1 CSA approved and ULC listed wire and cable, approved for fire alarm circuits; with colour coded, insulated solid copper conductors; of type as per local governing electrical code and local governing fire authority requirements.
- .2 Sized and installed in accordance with system manufacturer's instructions and local governing electrical code.
- .3 Fire rated MI for wiring as required by local governing building code, local governing authorities and as noted on drawings, for connections and interconnections to equipment for life safety applications.
- .4 To be mechanically protected to satisfaction of local fire authority.

2.11 **WARRANTY**

- .1 Warranty to include following:
 - .1 length of warranty as specified in Section 26 0010 and Division 01;
 - .2 repair or replacement warranty on components;
 - .3 warranty to begin upon substantial acceptance of project, or where applicable, phase of project; provide extended warranty for system if used during construction stages and which to cover period of construction before turning over to Owner;
 - .4 support of an operational remote maintenance capability;
 - .5 repair response times for problems defined as routine to be addressed and corrected within 24 hours, excepting statutory holidays and weekends;
 - .6 repair response times for problems defined as major to be addressed and corrected within 4 hours, excepting statutory holidays and weekends;
 - .7 manufacturers of major components to provide written confirmation of full warranty, extended warranty and service back-up in case of failure to perform or insolvency of successful supplier;
 - .8 maintain maintenance records for each system supplied, and submit a monthly report containing a time and date record of reported or detected problems, detail of corrective action taken and cause of problem.

2.12 **ACCEPTABLE MANUFACTURERS**

- .1 Manufacturer of the existing main building fire alarm system (products and work to be provided directly from manufacturer, unless otherwise noted) shall provide all fire alarm devices.
- .2 Viking Fire Protection – (416) 561-1018

3 Execution

3.1 **MONITORING OF SYSTEMS**

- .1 In area that remain occupied and used by Owner during the Work, the monitoring and supervision of the existing fire alarm system serving the renovated areas, must be monitored daily to ensure that system is left in proper operating condition at the end of each working day. Include for but not be limited to performing the following:
 - .1 under the presence of the Owner's representative, check each morning and evening (start and end of work) of each day, the system to ensure that it is in proper working condition;
 - .2 if portions of the system are not in proper working order, provide temporary bypass wiring (subject to approval of local fire authority), and/or provide supervisory personnel to monitor systems for the area affected;
 - .3 document and sign off with Owner's representative, each respective daily check condition;
 - .4 ensure that the work to system does not affect the portion of the system serving the areas outside of the renovation/working areas.

3.2 **INSTALLATION WORK TO EXISTING FIRE ALARM SYSTEM**

- .1 Provide relocation work and additional components as required. The sequence of operation of the system shall be retained. Program system to accommodate renovations works, to satisfaction of local fire authority and Consultant.
- .2 All work in conjunction with this installation shall meet the requirements of the latest editions of the OBC, OESC, Ontario Fire Code (OFC), ULC Installation Standard CAN/ULC S524 and any applicable local codes. All work performed on the existing fire alarm system shall be performed by qualified persons as defined in Section 1.2 of the OFC. If any requirements of these specifications are different, omitted or contrary to the ULC S524 Standard, then the ULC Standard shall govern and override these specifications, but in no instance will the standards established by the drawings and specifications be reduced by any of the Codes referred to previously. Control units and annunciators shall be in accordance to the latest requirements of ULC Standard CAN/ULC S527 "Control Units For Fire Alarm Systems.
- .3 During work to the existing fire alarm system, the time and duration of interruption shall be approved by the Owner. At any time due to emergency situations, Owner may request by-passed zone(s) to be re-instated immediately. In all areas where the renovation work requires shutdown of any part of the fire alarm protection system, provide manual fire alarm protection (Fire Warden) by means of supervising the area as approved by Governing Authorities. At no time shall the fire alarm system or any one (1) zone be left inoperative overnight. Provide all required bypass wiring and temporary wiring as may be required to maintain all parts of the fire alarm system operative during construction and alterations.

- .4 Verify with existing fire alarm system manufacturer during Bid period, the exact requirements needed to provide renovation work. If necessary, visit site with manufacturer to review existing conditions. Items of clarification or proposed revisions to Bid Documents must be reviewed with Consultant during Bid Period.
- .5 Prior to start of Work as part of shop drawing submission process, review with system manufacturer following:
 - .1 device types to ensure that selected type is suitable for intended application on project;
 - .2 locations of devices to ensure proper operation and coverage comply with requirements of local fire authorities;
 - .3 device mounting heights to ensure proper operation and coverage comply with requirements of local fire authorities;
 - .4 device back box requirements to ensure size and depth suit system manufacturer's recommendations for specific devices;
- .6 Allow for the existing building fire alarm system manufacturers to perform control panel/annunciator modification. System DGP to be programmed with sequence of operation matching existing system prior to completion of each phase.
- .7 Fire alarm system manufacturer's authorized technician to supervise control panel, transponder, and annunciator work.
- .8 Ensure that connections to existing systems serving the complex are provided such that activation of circuitry to transmit an alarm signal to Owner's monitoring company to send alarm signal to Fire Department or to an outside private protection company are maintained to existing standards as per requirements of CAN/ULC-S561.
- .9 Provide proposed drawing and sample of graphic display to Consultant for approval before manufacturing. Provide graphic annunciator in location as directed by Consultant.
- .10 Provide required devices. Circuit device's to existing standards and in compliance with local governing codes and authorities.
- .11 Properly ground and bond control panels, transponders and remote annunciator cabinets to building ground. Conduit ground will not be acceptable. Provide green coloured grounding loop, a minimum #10 AWG. insulated copper run in conduit. Connect ground loop to main building ground system source. Do not run ground wire in same conduit as fire alarm and communication wiring.
- .12 Installation of devices to be typically as per additional system devices specified later in this Section.
- .13 Perform Work in phases as specified in Divisions 00 and/or 01 and/or as noted on drawings.
- .14 Demonstrate system to local Fire Department and obtain their approval for complete system upon completion of each phase.

3.3 **INSTALLATION OF DEVICES**

- .1 Install required devices. Do not install devices in locations that may hamper proper operation of devices including adjacent devices.
- .2 Confirm device finishes with Consultant prior to ordering.

- .3 Install mounting plate of thermal detectors to ceiling mounted boxes as required. Secure detectors to plates. Refer to floor plans and drawing symbol list to determine rating of detectors in any given area. Generally, do not install rate-of-rise type detectors in areas subject to sudden changes in temperatures, such as entrance vestibules. Confirm application requirements with system manufacturer and ensure that devices are ULC listed for such applications and are approved by local fire authority for such use.
- .4 In application with hold open devices on doors, ensure compliance with NFPA regarding smoke detectors tied to hold open devices such that a signal received directly from smoke detector to cause release of door. Where electromagnetic locks are used on doors of egress, provide required automatic release of locks upon activation of fire alarm (i.e. via connection to auxiliary contact of adjacent pullstation). Provide required conductors and connections to fire alarm system and to electromagnetic locks.
- .5 Devices in non-climate controlled areas to be weatherproof, corrosion resistant, ULC listed for operation in below freezing temperatures, and as recommended by system manufacturer for use for each specific application. Where electronics are not recommended for cold temperature applications, include for manufacturer's recommendations and directions in remotely locating addressable modules in closest heated areas and connecting to respective device in non-climate controlled areas.
- .6 In areas of high abuse such as public parking areas and publically accessible areas, devices to include vandal resistant, tamperproof and vermin proof features such as guards, fasteners requiring use of special tools and fasteners not exposed.

3.4 **REQUIREMENTS FOR INTEGRATED SYSTEMS AND EQUIPMENT**

- .1 Perform required fire alarm system wiring connections to other building systems to perform required interrelated functions. Provide required wiring, relays and/or contactors between fire alarm system and various equipment to achieve automatic or manual control of equipment, to perform required integrated to fire alarm system functions. Provide shunt trip breakers as required.
- .2 Provision of fire alarm supervisory wiring connections to include but not be limited to following (where applicable):
 - .1 door holders/releases and electromagnetic locks;
 - .2 telephone system key switch for connection to offsite central monitoring station;
 - .3 security systems;
 - .4 devices as shown on drawings.
- .3 Interconnect fire alarm system to security system to provide a common "Alarm" signal to security system controls to release locked doors (designated by Owner) throughout the building on any or designated alarm condition. Interconnections between local fire alarm manual pull stations and local security system components door hardware to be provided in this manner. Coordinate work with respective system vendors and door hardware trade. Provide manual control switches for release and reset and mount onto control panel. Clearly label operators. Comply with local governing authorities regarding these requirements. Coordinate with General Contractor to obtain required Certificates of Approval for Work.
- .4 Include for coordination and cooperation to follow requirements of CAN-ULC/S1001.

3.5 **ADDITIONAL REQUIREMENTS**

- .1 Install wiring in conduit unless otherwise approved by Consultant. Perform wiring connections associated with fire alarm system on terminal strips in junction boxes and colour coded. Ensure that wiring colour coding is consistent for entire length of each run. When pulling wires into conduit, use lubricant and ensure that wires are kept straight and are not twisted or abraded. Neatly secure exposed wires in apparatus enclosures with approved supports or ties. Clearly identify wiring at each termination point. In addition, number wiring with Brady Ltd. or Electrovert Ltd. Z-type markers. Colour conductors for each part of system in accordance with system equipment manufacturer's recommendations. Paint conduit couplings red of paint type suitable for application to standards of Division 09.
- .2 Install wiring in accordance to requirements latest edition of applicable governing electrical code and to requirements of local governing authorities.
- .3 Run alarm indicating circuits (speakers) and alarm receiving circuits (pull stations, detectors) in separate conduits from each other.
- .4 Verify nomenclature of annunciator identification with Consultant and obtain necessary approvals prior to ordering.
- .5 Provide engraved Lamacoid identification nameplates for each equipment or wiring housing and secure to front of housing. Exact wording designations and sizes to be reviewed and confirmed with Consultant prior to manufacture.
- .6 Install end-of-line resistors to electrically supervise wiring. Generally, locate end-of-line resistors at ceiling lines above a pull station location. Provide isolators and install in accordance with ULC standards. Properly label and identify. Do not locate end-of-line resistors and isolators in concealed locations. Install in equipment rooms unless otherwise approved by Owner and Consultants.
- .7 Refer to drawing riser diagram and connection schedules. Quantities of components to be as per floor plans and not riser diagram.
- .8 Confirm exact location of components prior to roughing-in.
- .9 Ground and bond system as required by local governing electrical code and authority and system manufacturer.

3.6 **TESTING, VERIFICATION AND CERTIFICATION**

- .1 Provide testing, verification and certification of fire alarm system outlined in this section prior to completion of each construction phase.
- .2 Submit to Consultant for approval, proposed schedule for testing and verification of system. Obtain such approvals prior to start of testing. Refer to Division 00 and 01 for phasing requirements. Where areas of Work are to be phased construction and Owner requires to take occupancy, include for testing, verification and certification at each phase completion of Work, as required by local governing authorities. After completion of Work of last phase, include for total overall system testing, verification and certification of system.
- .3 Consultant and/or other Owner's representatives to have option to witness all or part of testing and verification work. Notify Consultant and Owner minimum seven (7) working days in advance of testing.

- .4 Include for fire alarm system manufacturer to inspect, test, verify and certify system components and wiring, individually and as a complete system, in accordance with requirements of latest edition of CAN/ULC S537. Work to include but not be limited to following:
 - .1 to ensure that type of equipment installed is that designated by Contract Documents;
 - .2 to ensure that wiring connections to equipment components show that installer observed ULC and CSA requirements;
 - .3 to ensure that equipment was installed in accordance manufacturer's recommendations, and that signalling devices of whatever manufacture were operated or tested to verify their operation;
 - .4 to ensure that supervisory wiring of those items of equipment connected to a supervised circuit is operating and that governmental regulations, if any, concerning such supervisory wiring, have been met to satisfaction of inspecting officials;
 - .5 to ensure that sequence of operation is in accordance with specified building sequence of operation and any modifications identified on documents and are approved by local fire authority;
 - .6 to ensure that devices are commissioned and operable.
- .5 System manufacturer to also be responsible for but not be limited to following:
 - .1 confirm that connections to security system and third party monitoring party are in accordance with CAN/ULC-S561;
 - .2 coordinate with local fire authority inspector and Electrical Division Contractor, required testing and verification work in order to obtain certification and meet local fire code and local fire authority requirements;
 - .3 verify fire alarm system on a zone by zone basis, and also verify entire system in whole, at completion of installation;
 - .4 test system battery power supplies and demonstrate compliance with local governing building code and local fire authority requirements that battery supplies are capable of providing required 24 hours of supervisory power followed by local governing building code required time (or time directed by local fire authority) of full load power; exact method of testing to be approved by local fire authority, Consultant and Owner; confirm exact procedures with previously named parties prior to testing; include for sufficient sound measurement devices and personnel in order to successfully comply with this requirement;
 - .5 full review, testing, and verification of operation of building ventilation and smoke exhaust system and its integrated operation with fire alarm system and various pieces of air handling equipment;
 - .6 full review, testing and verification of operation of integrated systems such as elevators and their emergency sequence of operation, supervisory annunciation of sprinkler/standpipe monitor switches, pressure switches and flow switches, diesel genset alarms, security alarms, BAS alarms, release of door holders and electromagnetic locks, air smoke sampling detectors, clean agent fire suppression tanks and release mechanism; pre-action sprinkler system; and any other integrated components; coordinate requirements with trades responsible for integrated components and systems who will be present at time of testing and verification work;

- .7 test that system audible devices provide alarm sound levels in areas as per local governing building code and local fire authority requirements; site adjust tap settings of audible devices as required to achieve required audibility levels; also test that emergency voice communication system meets or exceeds intelligibility requirements of local governing building code and is approved by local fire authority;
 - .8 assist in Testing and Verification of electromagnetic door locks to meet requirements of authorities having jurisdiction and to obtain overall approval of installation;
 - .9 coordination with Electrical Divisions and local fire authority to provide requirements needed to obtain certificates of approvals from local fire authority;
 - .10 provide full detailed test sheets of tested components and provide certification that system has been fully tested, that devices have passed testing and that system is in proper work order in compliance to code requirements and project documents; test documents to be additionally provided in electronic format as confirmed with Owner and Consultant.
- .6 Include for manufacturers' authorized technicians of fire detection air sampling smoke detectors and clean agent fire suppression system products to provide onsite inspection, testing, verification and certification of respective products and coordinate such work with overall system inspection, testing, verification and certifications.
- .7 Contact local fire authority inspector and coordinate and arrange for Fire Inspector to perform required inspections. Integrate local fire authority inspection requirements with testing and verification work to extent as per Fire Inspector's directions. Obtain full approval and certification by local fire authority.
- .8 Local fire authority inspector, Consultant and Commissioning Agent to at their discretion test system or parts of system in their review of test reports. Correct/repair any failures or deficiencies found in system, whether or not identified in test reports of manufacturer. Re-test and re-verify until successfully passed, at no extra cost to Owner.
- .9 Obtain from local fire authority required certificate of approval of system and forward to Consultant.
- .10 Arrange for manufacturers to supply reasonable amounts of technical assistance with respect to any changes required to conform to paragraphs above. During period of inspection, testing and verification, make Electricians available to do any required correction work and to assist during this Work. Include for trades responsible for integrated components (i.e. exhaust fans, sprinklers, elevators, gensets, etc.) and systems to be present at time of testing and verification work.
- .11 On completion of verification, inspection and testing of system, obtain from manufacturer and forward to Consultant, a verification certificate together with detailed inspection reports listing each and every system component, its location in building and its acceptability. Verification certificate and inspection reports to be prepared and signed by certified testing technicians of manufacturer. Signed test reports to confirm that systems are installed and perform in accordance with requirements specified above.
- .12 Obtain from system manufacturer and testing agency and forward to Consultant a certificate of liability insurance of minimum amount of Two Million Dollars (\$2,000,000.00) that is to be registered for this project to show satisfactory proof of manufacturer's liability coverage for both their product and personnel.
- .13 Unless approved in writing by Consultant and Owner, do not use open flame and/or smoke for testing.

- .14 Testing technician to be certified and approved for fire alarm system testing by Canadian Fire Alarm Association (CFAA) and local Fire Marshall as applicable.

END OF SECTION