

Table of Contents
Contract Specifications

Title	Section No.
Table of Contents	00010
Division 1 - General Requirements	
General Instructions	01100
Division 2 – Site Work	
Demolition and Removals	02100
Division 9 – Finishes	
Resilient Flooring	09651
Carpeting	09681
Painting	09910
Division 15 - Mechanical	
Mechanical Basic Materials and Methods	15100
HVAC Systems	15500
Building Automation System	15900
Division 16 - Electrical	
General Electrical Requirements	16010
Wires & Cables	16122
Electrical Boxes & Fittings	16132
Conduit, Fasteners & Fittings	16133

Table of Contents

1.0 General..... 1
 1.1. Overview 1
 1.2. Quality of Work Standards..... 1
 1.3. Bylaws and Permits 1
 1.4. Codes and Standards..... 1
2.0 Scope 1
 2.1. Mechanical 2
 2.2. Electrical 2
 2.3. General..... 3
 2.4. Building Envelope..... 4
3.0 Material and Equipment..... 4
4.0 Equipment Equivalency Approval 4
5.0 Shop Drawings and Manufacturer’s Data 4
6.0 As-Built Drawings 5
7.0 Manuals 5
8.0 Work Schedule 6
9.0 Project Meetings..... 6
10.0 Temporary Services 6
 10.1.General..... 6
 10.2.Electrical Power..... 6
 10.3.Water and Storm Water..... 6
 10.4.Temporary Toilet Facilities 7
 10.5.Temporary Storage..... 7
 10.6.Site Signs 7
11.0 Fire Safety Requirements 7
12.0 Contractor’s Use of Site..... 7
13.0 Cutting, Patching and Sleeving..... 8

14.0 Layout of Work 9

15.0 Existing Services 9

16.0 Existing Structure Shoring and Protection 9

17.0 Heating and Ventilating 9

18.0 Cleanliness and Removal of Rubbish..... 9

19.0 Final Finish and Clean Up 10

1.0 General

1.1. Overview

This multidisciplinary project includes major items such as the replacement of rooftop units, installation of a new Building Automation System and replacement of various flooring at Peterborough Fire Station #1.

The majority of the existing rooftop units are at the end of the life span and utilize R22 refrigerant, which was gradually phased out between 2010 and 2020. Existing facility control consists of various stand alone systems which will be replaced by the new Building Automation System. A newer monitoring panel for the standby generator is in the basement Electrical Room and will be retained for connection to the new BAS.

Refer to the Bid Documents for bid pricing structure, project schedule requirements, anticipated start date and total completion date.

1.2. Quality of Work Standards

Quality of work and method of installation shall conform to best standards and practice. Where required by local or other By-Laws and Regulations, tradespeople shall be licensed in their trade.

1.3. Bylaws and Permits

- Obey Government, Municipal and Underwriters Standards and perform work in accordance with requirements of By-Laws and Regulations in force where building is located.
- Apply for, obtain, and pay for permits and inspections required by authorities having jurisdiction. Furnish necessary certificates as evidence that work installed conforms to laws and regulations of authorities having jurisdiction. Make minor changes required by By-Laws and Regulations of authorities having jurisdiction without extra payment.

1.4. Codes and Standards

Installation must comply with latest editions and all amendments of the following codes and standards. Where conflicts in requirements occur, the higher standards will apply.

2.0 Scope

The project involves multiple disciplines. The following is a summary of the work from each discipline. Refer to the drawings and specifications for full definition of the scope.

2.1. Mechanical

- Remove and dispose of five (5) existing rooftop packaged heating/cooling units AC-2, 3, 4, 5, 6 as shown on drawings.
- Remove and dispose of two (2) Apparatus Bay ceiling hung hydronic unit heaters including piping as shown on drawings. Install insulation valves at the limits of pipe demolition to allow the system to continue to operate until the future hydronic system renovation/removal.
- Remove and dispose of two (2) existing gas fired radiant tube heaters as shown on plans.
- Furnish and install five (5) new rooftop packaged heating/cooling units AC-2, 3, 4, 5, 6 on new curb adapters as shown on drawings.
- Reconnect existing gas lines to new units and provide new condensate drains.
- Reconnect existing supply and return air ducts to new rooftop units. Include new transition pieces as required to accommodate addition of the curb adapters and new rooftop unit configuration.
- Control of new and existing rooftop units shall be assumed by the new BAS.
- Roofwork at new rooftop units as shown on Building Envelope drawings.
- Furnish and install two (2) new gas fired radiant tube heaters including extension of gas piping to furthest heater and new double wall B vents through roof.
- New 12" round vent through west wall of Apparatus Bay complete with exterior hooded wall vent. Include relocation of existing services as required to accommodate the new position of the Drying Cabinet.
- Relocate existing supply air diffuser in ground floor Reception area.
- New supply air diffuser in ground floor Office complete with flex duct connection to existing main duct and balancing damper.
- Air balancing for new rooftop units AC-2, 3, 4, 5 and 6.
- Permits and inspections as required.
- Startup, commissioning and verification of all new equipment.
- One year warranty on all materials and quality of work.

2.2. Building Automation System

- Furnish and install new Building Automation System as shown on plans.
- Furnish and install new BAS devices as shown on plans including temperature sensors, current sensors, low voltage power supplies, switches relays etc.
- Furnish and install all conduit and wiring as required to connect new BAS devices and interlocks.
- Remove and dispose of all decommissioned control devices.
- BAS startup, commissioning and verification.
- One year warranty on all materials and quality of work.

2.3. Electrical

- Lockout and tagging as required for equipment replacements.
- Disconnect existing 3/60/230V feeds to rooftop units.
- Verify conductor sizing to rooftops and reconnect to new rooftops including new weatherproof disconnects.
- New breakers for replacement rooftop units as shown on plans.
- Connect 3/60/230V feeds to new rooftop units. Note that new rooftop units will be placed on 14" curb adapters
- New 1/60/120V service receptacles on roof as shown on plans.
- Furnish and install two (2) new circulation fans in the Apparatus Bay as shown on plans.
- Relocate existing 1/60/120V power feeds from two (2) decommissioned Apparatus Bay radiant heaters to two (2) new Apparatus Bay radiant heaters as required.
- Relocate existing 1/60/120V power feeds from two (2) decommissioned Apparatus Bay hydronic heaters to Apparatus Bay circulation fans as required.
- Relocate existing services as required along west Apparatus Bay wall for the installation of the Drying Cabinet.
- Power and control wiring as required to complete mechanical and Building Automation System works including existing equipment removals, reuse and relocation, and new equipment as indicated.
- Grounding and bonding.
- Confirm and remove abandoned existing conduits and wiring as required and where practical.
- Cutting and patching of openings as required to complete installation.
- Permits and inspections as required.
- Startup, commissioning and verification of all new equipment.
- One year warranty on all materials and quality of work.

2.4. General

- Remove and dispose of carpeting on ground floor as shown on plans.
- Remove and dispose of existing tile and vinyl flooring in North East stairwell.
- Furnish and install new flooring on the ground floor as shown on plans (vinyl plank flooring in corridors and carpet tile in offices).
- Paint north east stairwell floors and stairs with one coat of catalyzed epoxy primer and two coats of catalyzed epoxy enamel, gloss. Enamel paint to be complete with suitable grit, polymer beads or silica sand, as recommended by the manufacturer.
- Clean and adequately prepare all flooring surfaces for recovering or painting including suitable underlayment where recommended by the manufacturer.

- New transition strips where required.
- All prep work to be in accordance with manufacturer's recommendations.
- One year warranty on all materials and quality of work.

2.5. Building Envelope

- Modify existing radiant tube heater vent openings through Apparatus Bay roof as required and seal new vent lines as shown on Building Envelope drawings.
- Seal new seam between new rooftop curb adapters and existing roof curb installations as shown on Building Envelope Drawings.
- New wall opening in west Apparatus Bay wall for installation of drying cabinet vent. Refer to Building Envelope drawings.
- Permits and inspections as required.

3.0 Material and Equipment

- Use new material and equipment unless otherwise specified.
- Use products of one manufacturer for equipment or material of same type or classification unless otherwise specified.
- Unless other specified, comply with manufacturer's latest published instructions for material and installation methods.
- Notify Owner in writing of any conflict between these specifications and manufacturer's instructions. Owner will designate which document is to be followed.

4.0 Equipment Equivalency Approval

- A Tender must be submitted based on materials and products shown on the Drawings and Specifications. Alternate equivalent materials and products may be used provided they are approved by the Consultant. Submission for equivalency approval must be within the designated question period and follow the procedure defined in the Bid documents. Materials and products shall be deemed equal to those specified provided they have capacity, performance, rating, construction, physical dimensions, accessories and features which, in the opinion of the Consultant, are equal to materials and products specified. Submissions must contain all the relevant data required for comparison and evaluation.
- Where an equivalent material or product is approved, the Contractor shall be responsible for and carry all costs associated with any modifications to the design and work as shown, both structurally and otherwise. The Contractor shall submit shop drawings for approval showing modifications including layouts and elevations.

5.0 Shop Drawings and Manufacturer's Data

- Throughout the specifications, requirements are listed for the submission of shop drawings and manufacturer's data. The General Contractor is

responsible for the submission and receipt of acceptances and approvals to ensure unnecessary work delays.

- Include operating and maintenance instruction for mechanical and electrical equipment.
- If a manufacturers' standard brochure is submitted, the actual piece of equipment complete with variations supplied is to be indicated on the brochure.
- The General Contractor shall submit electronic copies in pdf format of Shop Drawings for equipment, components etc. The Consultant will review the shop drawings expeditiously to ensure their compliance with contract documents.

6.0 As-Built Drawings

- Maintain at the site, one set of white prints of the plans in order to record any deviations from the contract plants.
- Update this record daily and make record available for inspection.
- Transmit these record drawings to the Owner at the close of the project. The Consultant shall provide to the Contractor drawings to be marked up and labelled As-Built. Electronic PDF versions shall be submitted to the owner as part of the electronic O & M manuals to be submitted. One marked up white print set shall be given to the facility manager at the close of the project.

7.0 Manuals

Operation and Maintenance manuals shall include, but not be limited to the following:

- Table of Contents,
- All submitted shop drawing and manufacturer's data including equipment manufacturer's performance data sheets, servicing, maintenance, operating, and trouble-shooting instructions for each item of equipment and specialty product,
- Equipment performance verification test results,
- Operating instruction for each system and each component,
- Description of actions to be taken in the event of equipment failure,
- All inspection, registration, guarantee and warranty certificates.

Submit one (1) hard copy and one (1) electronic copy of Operation and Maintenance Manual for all equipment covered under this contract including As Built drawings. Hard copy shall be in a 3 ring binder for Facility use and electronic copy on a flash drive for City use.

Manuals will be supplied to the Owner prior to commissioning. Holdback for incomplete or unacceptable manuals will be at Owner's discretion.

8.0 Work Schedule

- Within timeframe stated in Bid Documents, prepare and submit in a form acceptable to the Owner a detailed Work Schedule, clearly showing equipment lead times, the anticipated progress stages, start and finish date of each construction phase, down-time of each system during tie-in and date of final completion within the time period required by the contract documents.
- On approval of the Work Schedule by the Owner, proceed to ensure completion of work within the scheduled time. Carry out work in a continuous manner. If at any time one phase falls behind schedule, take necessary measures to expedite subsequent phases to maintain or improve on completion date. Interim review of the work progress shall be conducted as decided by the Owner.

9.0 Project Meetings

The Owner or their designee will call an Initial Project Meeting. Owner's staff and their Consultants will be invited. The General Contractor will invite their subcontractor's key staff, if applicable.

- The agenda of the briefing meeting will include:
- Introducing key personnel participating in the project.
- Establishing limits on work hours, access, movements on site, parking, etc.
- Review of the Work Schedule.
- Establishing administrative and procedural matters.
- Providing procedural forms and communications routing.
- Establishing the schedule for project meeting.

10.0 Temporary Services

10.1. General

The Contractor is responsible for providing temporary services during the contract for all construction purposes, unless specifically noted to the contrary.

10.2. Electrical Power

Electrical power is available from existing receptacles and panels spare breakers. The Contractor shall make all necessary temporary connections. Electrical power requirements exceeding this shall be provided by the Contractor and the cost included in the Tender Price.

10.3. Water and Storm Water

- Water supply is available on site at no cost to the Contractor for nominal construction work, cleaning, etc.

- Should the Contractor require excessive volumes of water for their operations or the operation of their equipment, they shall make all arrangements for and pay for such water usage.
- The Contractor shall supply their own hoses, pails and equipment.
- The Contractor is required to maintain Storm water Management measures & facilities and site grading.

10.4. Temporary Toilet Facilities

- Provide toilet facilities if and where directed and maintain to Provincial and Municipal Sanitary regulations.
- Remove when work is complete and restore area to original condition.

10.5. Temporary Storage

- Storage facilities will not be provided within the building for the storage of construction materials.
- Provide suitable coverings for materials that are to remain dry.
- Deliver, store and maintain packaged materials and equipment with manufacturer's seals and labels intact.
- Prevent damage, adulteration and soiling of material and equipment during delivery, handling and storage. Immediately remove rejected materials and equipment from site.
- Store and maintain material and equipment in accordance with manufacturer and supplier instructions.

10.6. Site Signs

No signs or advertisements of any description, other than those regarding safety, caution and instructions shall be permitted.

11.0 Fire Safety Requirements

Comply with the Ontario Fire Code by:

- Maintaining existing and temporary fire exits.
- Maintaining and protecting continuing service lines.
- Providing fire watches as required.
- Management of combustible salvage, waste and rubbish.
- Protecting persons and properties.
- Maintaining operable fire protection equipment.
- Maintaining fire fighter's access.
- Providing temporary fire extinguishing equipment.

12.0 Contractor's Use of Site

- Repair promptly any damages or such claim for damages as a direct or indirect result of their operations.

- Supply, erect, maintain and remove protective barriers to the complete satisfaction of the Owner and in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects.
- Maintain existing and required traffic operation measures and facilities. Provide Traffic control when required, in accordance with City of Peterborough standards.
- Do not permit public access to the construction area or to areas immediately adjacent to work area.
- Control dust from construction operations to the complete satisfaction of the Owner as well as to municipal and provincial regulations.
- All shoring, protection barriers, signage, dust control, noise control, etc. shall be inclusive to the contract and no further or separate payment shall be made.
- Limit use of site for work and storage as directed by the Owner.
- Do not unreasonably encumber site with materials or equipment, obtain and pay for all additional storage or work areas needed for operation.
- Do not obstruct entrance, stairs or fire exits.
- Maintain free access route for fire, ambulance and garbage truck.
- Make good damage to paving, grass, walkways, curbs, trees, planting beds, etc. caused due to the work of this Contract.
- Limited parking is available on site. Number and location of parking spaces for Contractor's use will be determined by Owner.

13.0 Cutting, Patching and Sleeving

- Inspect existing conditions including elements subject to damage or movement during cutting and patching.
- Obtain the Owner's representative approval before cutting, boring or sleeving load-bearing members.
- X-ray existing concrete structure for utility locates prior to coring or cutting of concrete.
- Where work connects with existing and where existing work is altered, cut, patch and make good to match existing.
- Where pipes pass through masonry walls, supply and install suitable 18 gauge galvanized steel sleeves. Size sleeves on insulated pipes to permit insulation to continue through sleeves. Sleeve ductwork similarly.
- Where pipes pass through concrete or frame construction, supply and install 18 gauge galvanized steel sleeves. Provide copper sleeves on copper pipe.
- Seal spaces between pipes and ducts through required fire separations with U.L.C. listed fire stopping including pipe insulation.
- Seal all holes and openings through floors water tight. Where ducts pass through floors, provide seals. Locate openings in field to be snug around ducts and be responsible for correct size and location.

14.0 Layout of Work

- Layout all parts of the work in accordance with lines, levels, elevations, and measurements shown on the drawings. Errors resulting from failure to verify figures or the proper layout of any element of the installation shall be rectified without additional cost.
- Thoroughly examine existing conditions and confirm locations and routing of all components of the work prior to bidding and installation. Allow for relocation of existing services or offsets in work where interferences are unavoidable.

15.0 Existing Services

- Before commencing work, establish location and extent of services and utilities in areas of work (i.e. wiring, natural gas piping, etc).
- Where unknown services are encountered, immediately advise Owner and confirm findings in writing.
- Maintain existing services in work areas that must remain active, make good all damages to existing services resulting from the work.

16.0 Existing Structure Shoring and Protection

- Consider hazards to existing structure during work and report immediately to the Owner any present or expected dangerous conditions.
- Any damage caused by shoring and protection, or lack thereof shall be the full responsibility of the Contractor and shall be made good to the full satisfaction of the Owner.

17.0 Heating and Ventilating

- Irrespective of the time of the year, the Contractor shall pay for temporary heat or ventilation used for their operations or requirements and/or the requirements of these documents during construction, including the cost of installation, fuel, operation, maintenance and removal of equipment. This shall include the operations and requirements of subcontractors.
- Do not use direct-fired heaters discharging combustion gases into the work areas.
- Fumes, odours, dust and deleterious matter entering City occupied work or other areas will not be tolerated. Take any and all necessary precautions to avoid these conditions arising during, or as a direct or indirect result of operations.

18.0 Cleanliness and Removal of Rubbish

- Keep the building site and work areas free from accumulation of dirt, debris and excess materials. Contractor's construction management to include

adherence to City of Peterborough standards including Dust Control and Traffic Control.

- At the end of each working day, clean all areas.
- Maintain all facilities necessary to permit the Owner to continue to collect solid waste and recyclable material.
- Remove waste from premises at the close of each day or more often, if required.
- Provide and maintain until the work is complete, main refuse containers on the site. Empty the refuse containers at frequent intervals to avoid spillage or overloading.
- Fires are not permitted on the site.
- Remove from the site and dispose of all waste materials.
- Do not dispose of wastes or volatile materials such as mineral spirits, oil and paint thinners into storm or sanitary sewers.
- Store volatile wastes in covered metal containers and remove from premises daily.
- Provide adequate ventilation during use of volatile or noxious substances.
- Use only cleaning materials recommended by manufacturer of surface to be cleaned and as recommended by cleaning material manufacturer.

19.0 Final Finish and Clean Up

- Upon completion of the work and immediately prior to final inspection by the Owner, the Work shall be thoroughly cleaned and made ready for immediate occupancy.
- Use appropriate apparatus and cleaning materials. Clean in strict accordance with manufacturer's and supplier's directions.
- Leave site clean of debris in a broom clean condition.

End of Section

Table of Contents

1.0	General.....	1
1.1.	Scope	1
1.2.	Related Sections	1
1.3.	Standards and References.....	1
2.0	Products	2
3.0	Execution.....	2
3.1.	Preparation and Protection.....	2
3.2.	Operations.....	2
3.3.	Completion	3

1.0 General

1.1. Scope

Under this section, the Contractor shall provide all services, complete in all respects to the full intent of the drawings and specifications, including the following:

- Provide materials, labour, equipment, rentals, haulage and disposal for demolition and removal work described herein, and as necessary to complete the work. Arrange and pay for necessary permits for proper execution and completion of this work.
- Before commencing demolition, contact utilities and authorities having jurisdiction. Carry out disconnections and cappings to their requirements, employing tradespeople licensed for this work. Pay for regulatory authority inspection and service fees.
- After identifying removal methods, determine areas of possible vibration. Carefully inspect beyond those adjacent areas. List potential damage spots, ie. existing cracks, exposed glass, etc., and photograph each for record purposes before starting work.
- Where requested, submit drawings, diagrams and details clearly showing sequence of dismantling the work, supporting and shoring details, and related demolition details.
- Fully protect areas of work and adjacent areas and ensure free safe passage at all times.

1.2. Related Sections

Each section of the specifications and drawings is not necessarily complete in itself and all sections of the specifications and drawings are related. The Contractor shall read each section in conjunction with all of the other Contract Documents. The Contractor shall also ensure that all Subcontractors read the relevant documents and comply with the requirements.

- Division 1 General Requirements
- Division 15 Mechanical
- Division 16 Electrical

1.3. Standards and References

- CSA S350-M80, Code of Practice for Safety in Demolition of Structures.
- OHSA, Occupational Health and Safety Act.
- Provision of fire extinguishing equipment and regulations of authorities having jurisdiction.

2.0 Products

Not Used

3.0 Execution

3.1. Preparation and Protection

- Erect and maintain barriers surrounding construction area as required.
- Protect mechanical and electrical equipment from damage during the work.
- Protect existing materials and components which are not to be demolished.
- Prevent movement of structure; provide bracing and shoring as required. Temporary shoring shall be inclusive to the Contract and no further or separate payment shall be made.
- Any damage caused by shoring or lack thereof shall be the full responsibility of the Contractor and shall be made good to the full satisfaction of the Owner with no extra to the Contract.
- Notify affected utility companies before starting work and comply with their requirements.
- Mark location and termination of utilities.
- Maintain existing utilities in areas of the building that must remain active during construction.
- Do not disable or disrupt building fire or life safety systems without three (3) days prior written notice to Owner.

3.2. Operations

- Carry out work in a systematic manner as necessary to accommodate demolition, removal, and reconstruction. Schedule work to coincide with related new construction. Contractor shall allow for all demolition work to coincide with project schedule.
- Ensure work is supervised by an experienced, competent site supervisor at all times. Employ skilled and experienced personnel to perform alteration and demolition work.
- Conduct demolition to minimize interference with adjacent and occupied building areas and adjacent public access.
- Cease operations immediately if structure appears to be in danger and notify Consultant. Make safe and do not resume operations until directed.
- At the end of each days work, leave site in a safe condition. Do not stack salvaged materials or debris liable to overload any part of the structure.
- Protect building interiors from the elements at all times. Protect building roof, exterior and parking areas from damage due to construction activities.

- Reinstallation items: carefully remove materials and equipment employing competent tradespeople. Store, protect and reinstall as required.
- Remove materials as work progresses. Dispose of demolished, broken and non-reusable materials immediately from the site. Remove organic, metallic, contaminated or dangerous materials from the site and ensure safe disposal.
- Minimize dust during demolition. Minimize traffic, dust, soiling of adjacent parts of building and building property not being renovated.
- Should asbestos material be encountered in the course of demolition work, stop work and notify the City.
- Remove, cut, and patch work in a manner to minimize damage and to provide means of restoring products and finishes to original or specified condition.
- Where new work abuts or aligns with existing, provide a smooth and even transition.
- Patch work to match existing adjacent work in texture and appearance.
- When finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and submit recommendation to Consultant for review.

3.3. Completion

- Remove temporary work, shoring, and bracing at completion.
- Rectify damage done to any facility service such as existing mechanical heating and ventilation, plumbing or electrical systems damaged during execution of this work.
- Repair and/or replace all paving, sod, curbs, and structures damaged by construction activities including vehicles, to original conditions to the satisfaction of the Owner.
- Leave site clean of debris in a broom clean condition.

End of Section

Table of Contents

1.0	General.....	1
1.1.	Submittals.....	1
1.2.	Quality Assurance	1
1.3.	Delivery, Storage, and Handling	1
1.4.	Project Conditions	1
2.0	Products	1
2.1.	Vinyl Plank Flooring.....	1
3.0	Execution.....	2
3.1.	Examination.....	2
3.2.	Preparation.....	2
3.3.	Cleaning and Protection	3

1.0 General

1.1 Submittals

- Product Data: For each type of product indicated.
- Samples for Initial Selection: For each type of product indicated.

1.2 Quality Assurance

- Installation Qualification: Contractors for floor covering installation should be experienced in managing commercial flooring projects and provide professional installers, qualified to install the various flooring materials specified.

1.3 Delivery, Storage, and Handling

Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained between 55°F and 85°F.

1.4 Project Conditions

- Install resilient products after other finishing operations, including painting, have been completed.
- Maintain ambient temperatures between 65°F and 85°F in spaces to receive resilient products during the following time periods:
 - 48 hours before installation.
 - During installation.
 - 48 hours after installation.
- Maintain the ambient relative humidity between 40% and 60% during installation.

2.0 Products

2.1 Vinyl Plank Flooring

Provide Coretec Pro Plus XL vinyl plank flooring in ground floor corridors as shown on plans.

- Thickness: 0.177" (4.5 mm).
- Wear layer thickness: 0.020" (0.5 mm).
- Colors and Patterns: To be selected by Facility Staff

3.0 Execution

3.1 Examination

- Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the work.
- Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Preparation

- Ensure the surface preparation is in compliance with the manufacturer's recommendations. Identify existing conditions that are non compliant to the Owner and Consultant.
- Concrete floors must be free of dust, solvent, paint, wax, oil, grease, residual adhesive, adhesive removers, film-forming curing compounds, silicate penetrating curing compounds, sealing, hardening or parting compounds, alkaline salts, excessive carbonation or laitence, mold, mildew, and other foreign materials that may affect dissipation rate of moisture from the concrete, discoloration or adhesive bonding.
- Mechanically remove contamination on the substrate that may cause damage to the resilient flooring material. Permanent and non-permanent markers, pens, crayons, paint, etc., must not be used to write on the back of the flooring material or used to mark the substrate as they could bleed through and stain the flooring material.
- A pH test for alkalinity must be conducted on the concrete floor prior to installation with results between 7 and 9. If the test results are not within the acceptable range, then installation must not proceed until the problem has been corrected.
- Fill cracks, holes, depressions and irregularities in the substrate with good quality Portland cement based underlayment leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- Floor covering shall not be installed over expansion joints.
- Do not install resilient products until they are same temperature as the space where they are to be installed.
- Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.3. Cleaning and Protection

- Comply with manufacturer's written instructions for cleaning and protection of resilient products.
- Perform the following operations immediately after completing resilient product installation:
 - Remove adhesive and other blemishes from exposed surfaces.
 - Sweep and vacuum surfaces thoroughly.
 - Damp-mop surfaces to remove marks and soil.
- Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
 - No traffic for 24 hours after installation.
- Wait 72 hours after installation before performing initial cleaning.
- A regular maintenance program must be started after the initial cleaning.

End of Section

Table of Contents

1.0	General.....	1
1.1.	Scope	1
1.2.	Submittals.....	1
1.3.	Samples	1
1.4.	Maintenance Material Supply	1
1.5.	Quality Assurance	1
1.6.	Warranty Requirements.....	2
2.0	Products	2
2.1.	Modular Carpet.....	2
3.0	Execution.....	2
3.1.	Examination.....	2
3.2.	Field Conditions and Installation.....	3
3.3.	Cleaning and Protection	4

1.0 General

1.1. Scope

This section covers the specification standards for modular carpet including construction, submittals, installation and warranty information.

1.2. Submittals

- Include Manufacturer's written specification and warranty information in its entirety regarding the specified carpet to be installed on the project. The specification must clearly state the Manufacturer's name, style/collection, pattern and color of the product. It must also include all physical attributes e.g. durability, fade resistance) of the product within the specification.
- Include manufacturer's installation recommendations for each type of substrate related to the project.
- Type, color, and location of edge, transition, and other accessory strips.

1.3. Samples

For each of the following products and for each color and texture required. Label each sample with Manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in Schedules.

- Carpet Tile: (2) - Full-size Samples.
- Exposed edge, Transition strips and other accessory stripping: 12" long sample.

1.4. Maintenance Material Supply

Furnish extra materials, from the same product run and dye lot that match products installed. Carpet should be in its original packaging with protective covering for storage and identified with labels describing contents.

- Carpet Tile: Ten (10) Full-size units for each type installed.

1.5. Quality Assurance

- Installer Qualifications: The Owner and Consultant may request the resume of the installation company. Installers shall have experience in similar installation methods.
- Fire-Test-Response Ratings: Where indicated, provide carpet identical to those of assemblies tested for fire response according to NFPA 253 by a qualified testing agency.
- Mockups: The Owner and Consultant may require a mockup for certain carpet applications.

1.6. Warranty Requirements

Warranty for Modular Carpet: The Warranty information listed below are the minimums permissible. Manufacturer agrees to repair or replace components of modular carpet installation that fail in materials or quality of work within specified warranty period.

- Warranty Period: Minimum 15 years from date of occupancy. Chairpads shall not be required to maintain warranty.
- Back Delamination – lifetime.
- Edge Ravel – lifetime.
- Static Protection –lifetime.
- Wear – surface wear shall not be greater than 10% by weight for the first 15 years.

2.0 Products

2.1. Modular Carpet

Listed below are the minimum specifications for modular carpet.

- Philadelphia Commercial Mystify series or approved equivalent
- Fiber: Type 6,6 Nylon fibers.
- Pile Weight: 17 oz
- Pile Construction: Loop construction.
- Gauge: 1/10"
- Construction: Tufted or Woven
- Density: High Traffic Areas & Dormitories 6,500; All other areas 5,500
- Backing: High performance backing with moisture barrier
- Size: 24" x 24". Other sizes to be approved by Facility Staff.
- Recycled Content: 25%
- Flammability: Radiant Panel Test ASTM E-648, Class 1. Methenamine Pill Test, ASTM-D 285-96, shall pass FF1-70 or FF2-70. Smoke Density ASTM E-662 rating must be less than 450 in flaming mode. Verify that all Flammability guidelines meet the most strenuous regulations.

3.0 Execution

3.1. Examination

- Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.

- Examine carpet tile for type, color, pattern, and potential defects.
- Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
 - Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond.
 - Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
 - Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
- For wood subfloors, verify the following:
 - Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.
- For metal subfloors, verify the following:
 - Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.
- For painted subfloors, verify the following:
 - Perform bond test recommended in writing by adhesive manufacturer.
- For raised access flooring systems, verify the following:
 - Access floor substrate is compatible with carpet tile and adhesive if any.

- Verify that underlayment surface is flat, smooth, evenly planed, tightly jointed, and free of irregularities. Ensure no gaps greater than 1/8" nor protrusions more than 1/32" exist and there are no substances that may interfere with adhesive bond or show through surface.
- Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. Field Conditions and Installation

- Comply with Manufacturer's written installation instructions for preparing substrates indicated to receive carpet installation.
- Use trowelable leveling and patching compounds, according to Manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8" wide or wider and protrusions more than 1/32" unless more stringent requirements are required by Manufacturer's written instructions.
- Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by Manufacturer.
- Clean metal substrates of grease, oil, soil and rust, and prime if directed by Adhesive Manufacturer.

- Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
- Broom and vacuum clean substrates to be covered immediately before installing carpet tile.
- Comply with Manufacturer's requirements for temperature, humidity, ventilation limitations and installation methods for the particular subfloor or substrate. If the manufacturer does not have a set standard, reference the Carpet and Rug Institute Carpet Installation Standard 2011, First Edition.
- Environmental Limitations: Do not deliver or install carpet until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.
- Do not install carpet over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet Manufacturer.
- Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.
- All installation must meet the Manufacturer's guidelines. This is extremely important when concerning the warranty of the product.
- Installation Method: A "NO-Glue Grid" method of installation is preferred if feasible and available on modular carpet only. Other adhesives shall be of low odor/solvent content. Verify that the installation method and only use products recommended by the Manufacturer.
- Maintain dye lot consistency throughout the project.
- Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by Manufacturer.
- Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, non-staining marking device.
- Stagger joints of modular carpet so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.3. Cleaning and Protection

Perform the following operations immediately after installing carpet:

- Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
- Remove yarns that protrude from carpet tile surface.
- Vacuum carpet according to manufacturer's guidelines.

- Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet Manufacturer.

End of Section

Table of Contents

1.0	General.....	1
1.1.	Scope	1
1.2.	Related Sections	1
1.3.	References	1
1.4.	Submittals.....	1
1.5.	Qualifications	1
1.6.	Delivery, Storage, and Handling	1
1.7.	Environmental Requirements	2
2.0	Products	2
2.1.	Materials.....	2
2.2.	Finishes	2
3.0	Execution.....	2
3.1.	Examination.....	2
3.2.	Preparation.....	2
3.3.	Application.....	3
3.4.	Finishing Mechanical and Electrical Equipment	4
3.5.	Cleaning	4
3.6.	Schedule - Exterior Surfaces.....	4
3.7.	Schedule - Interior Surfaces	4
3.8.	Schedule - Colours	5

1.0 General

1.1 Scope

- Surface preparation and field application of paints and coatings.

1.2 Related Sections

- Division 1 General
- Division 15 Mechanical
- Division 16 Electrical

1.3 References

- ASTM D16 - Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related
- ASTM D2016 - Test Method for Moisture Content of Wood.
- NPCA (National Paint and Coatings Association) - Guide to U.S. Government Paint
- MPI (The Master Painters Institute) - Architectural Painting Specification Manual

1.4 Submittals

- Samples: Submit two samples, 100 x 100 mm in size illustrating selected colours.

1.5 Qualifications

- Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum five years documented experience.
- Applicator: Company specializing in performing the work of this section with minimum Five years documented experience.
- Acceptable manufacturers, materials, quality of work and all items affecting the work of this section is to be in accordance with The Master Painters Institute Architectural Painting Specification Manual.

1.6 Delivery, Storage, and Handling

- Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, colour designation, and instructions for mixing and reducing.
- Store paint materials at minimum ambient temperature of 7 °C and a maximum of 32 °C, in ventilated area, and as required by manufacturer's instructions.

1.7. Environmental Requirements

- Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
- Minimum Application Temperatures for Latex Paints: 7 °C for interiors; 10 °C for exterior; unless required otherwise by manufacturer's instructions.
Provide lighting level of 860 lx measured mid-height at substrate surface.

2.0 Products

2.1. Materials

- Use factory-mixed paint suitable for the intended surfaces. Paint should apply smoothly, cover evenly, and dry without visible streaks or drips.
- Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified, of commercial quality.
- Patching Materials: Latex filler.
- Fastener Head Cover Materials: Latex filler.

2.2. Finishes

- Refer to schedule at end of section for surface finish and colour schedule.

3.0 Execution

3.1. Examination

- Verify that surfaces are ready to receive work as instructed by the product manufacturer. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- Test shop applied primer for compatibility with subsequent cover materials. Do not apply finishes unless moisture content of surfaces are below the paint manufacturer's recommended maximums

3.2. Preparation

- Remove electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
- Correct defects and clean surfaces which affect work of this section. Remove existing coatings that exhibit loose surface defects.
- Impervious Surfaces: Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

- Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.
- Gypsum Board Surfaces: Fill minor defects with filler compound. Spot prime defects after repair.
- Concrete and Unit Masonry Surfaces Scheduled to Receive Paint Finish: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter.
- Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.
- Uncoated Steel and Iron Surfaces: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by hand, power tool, wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Spot prime paint after repairs.
- Shop Primed Steel Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Prime metal items including shop primed items.
- Interior Wood Items Scheduled to Receive Paint Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats.
- Interior Wood Items Scheduled to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats.

3.3. Application

- Apply products in accordance with manufacturer's instructions.
- Do not apply finishes to surfaces that are not dry.
- Apply each coat to uniform finish.
- Apply each coat of paint slightly darker than preceding coat unless otherwise approved. Sand wood and metal lightly between coats to achieve required finish
- Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
- Allow applied coat to dry before next coat is applied.
- Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- Prime concealed surfaces of interior woodwork with primer paint.
- Prime concealed surfaces of interior woodwork scheduled to receive stain or varnish finish with gloss varnish reduced 25% with mineral spirits.

3.4. Finishing Mechanical and Electrical Equipment

- Refer to Division 15 and Division 16 for schedule of colour coding and identification banding of equipment, duct work, piping, and conduit.
- Paint shop primed equipment.
- Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- Prime and paint insulated and exposed pipes conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports.
- Paint interior surfaces of air ducts, and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint, to visible surfaces. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
- Paint exposed conduit and electrical and mechanical equipment occurring in finished areas.
- Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.5. Cleaning

- Collect waste material which may constitute a fire hazard, place in closed metal containers and remove daily from site.

3.6. Schedule - Exterior Surfaces

- Pavement Markings: One coat of Traffic paint, yellow.
- Steel - Unprimed: One coat of alkyd primer. Two coats of alkyd enamel.
- Steel - Shop Primed: Touch-up with zinc chromate primer. Two coats of alkyd enamel.

3.7. Schedule - Interior Surfaces

- Wood - Painted: One coat of alkyd prime sealer. Two coats of alkyd enamel.
- Wood - Transparent: One coat of semi-transparent varnish stain. two coats of clear varnish.
- Steel - Unprimed: One coat of alkyd latex primer. Two coats of alkyd latex enamel.
- Steel - Primed: Touch-up with alkyd primer. Two coats of alkyd enamel.
- Steel - Galvanized: One coat galvanize primer. Two coats of alkyd enamel.
- Gypsum Board: One coat of alkyd primer sealer. Two coats of latex acrylic enamel.
- Concrete Floors: One coat of catalyzed epoxy primer, Two coats of catalyzed epoxy enamel, gloss.
- Exposed structural steel and steel deck ceilings. One coat primer, Two coats dryfall paint eggshell finish

3.8. Schedule - Colours

- Mechanical and Refrigeration components: As per Division 15
- Electrical components: To match existing where applicable.
- New concrete flooring and stairs to be painted in beige or grey. Provide sample to Owner for review.
 - Sherwin-Williams ResuGrip 175 or approved equivalent
 - Additional grit as required to suit as recommended by the manufacturer.

End of Section

Table of Contents

1.0 General..... 1

 1.1. Overview 1

 1.2. Requirements of Regulatory Agencies 1

 1.3. Discrepancies 1

 1.4. Omissions..... 1

 1.5. Deficiency Lists..... 1

 1.6. Equipment Tags and Identification 1

 1.7. Equipment Guarantee 1

 1.8. Warranty 2

 1.9. Delivery, Storage and Handling 2

 1.10. Electrical & Instrumentation 2

2.0 Products 2

 2.1. Equipment 2

 2.2. Fasteners 3

 2.3. Electric Motors..... 3

 2.4. Belt Drives 3

 2.5. Electrical Work..... 4

 2.6. Equipment Access..... 4

 2.7. Lubricants..... 4

 2.8. Instruments and Gauges 4

 2.9. Special Tools and Spare Parts 5

 2.10. Equipment Nameplates 5

 2.11. Access Doors 5

3.0 Execution..... 5

 3.1. Examining Conditions..... 5

 3.2. Equipment Installation 5

 3.3. Pipe and Fitting Installation 6

 3.4. Location of Instruments, Gauges, and Controls 8

 3.5. Flashings 8

 3.6. Hangers..... 9

 3.7. Painting 11

3.8. Identification of Equipment 11
3.9. Identification of Ductwork 11
3.10. Identification of Piping 11
3.11. Testing, Start-up, Commissioning and Training..... 12

1.0 General

1.1. Overview

- Supply, install and satisfactorily operate mechanical systems complete in all respects.
- Provide mechanical work in a practical and first-class manner, and guarantee all work and apparatus against defects of quality of work and materials, and make good any and all defects which may develop.

1.2. Requirements of Regulatory Agencies

- Materials, equipment, and quality of work shall comply with codes and standards of the Municipality, Province, and Country in which the Work is being executed.
- Codes and standards referred to in this Section shall be the latest editions in force.

1.3. Discrepancies

- Report discrepancies and/or 'errors and omissions' to the Consultant.

1.4. Omissions

- The Contractor shall incorporate into the work any piping, valves, etc. shown on the Drawings by symbol, but not described or scheduled as required for a fully functional system.

1.5. Deficiency Lists

- Advise the Consultant when work will be ready for inspection.
- Maintain a list of deficiencies revealed by various inspections.
- Rectify deficiencies as quickly as possible.

1.6. Equipment Tags and Identification

- All items shall be tagged with a weather-resistant tag attached in such a manner as not to be lost in transit. Each tag must contain the following data: Equipment Tag Number and Equipment Title. All lettering must be clearly identifiable.
- Major Equipment: All items shall have the information requested clearly labelled using black lamacoid nameplates with white letters 1" high, figured in such a location as to be easily identified during construction.

1.7. Equipment Guarantee

- Mechanical equipment shall operate satisfactorily without excessive wear, lubrication, or undue attention from the operator. All rotating parts shall be

in true balance, and operate without vibration caused by mechanical defects or misalignment of parts.

- Each item of mechanical and electrical equipment shall be guaranteed against: a) faulty or inadequate design/manufacture, b) improper assembly, c) defective material or quality of work, and d) leakage, breakage or other failure which might occur under normal and proper operation of the equipment, for a period of one (1) year after acceptance of equipment. Each item of equipment proving defective shall be made good by the Supplier without cost to the City.

1.8. Warranty

- Furnish to the Owner through General Contractor and Consultant, written warranty covering materials and quality of work and free service for one (1) year from date of start of substantial performance.
- Warranty shall entail repair or replacement of materials installed without charge to the Owner except where, in opinion of Consultant, such repair or replacement was caused by improper use or lack of proper maintenance.

1.9. Delivery, Storage and Handling

- Replace products found to be defective in manufacture and fabrication, or damaged in handling after delivery; including the labour required for replacing products found to be defective.
- Place products in safe storage. Keep interiors of equipment, pipes, fittings and other accessories clean.

1.10. Electrical & Instrumentation

- Work done under Division 15 shall conform to, and be coordinated with the requirements of Division 16.
- Control wiring and conduit shall be as indicated in the Canadian Electrical Code, and quality of materials and quality of work shall be in accordance with best practice.

2.0 Products

2.1. Equipment

- Where possible, use the products of a single Supplier for equipment or material of same type or classification.
- Materials, equipment, and plant shall be of proven design and quality, and shall use current models with published ratings for which replacement parts are readily available.
- Follow codes of practice, standards of City, Province, and Country. Follow policies of Suppliers for safety, inspection access, maintenance, repairs, etc.

2.2. Fasteners

- Space anchors within limits of load bearing capacity and ensure they provide positive anchorage.
- Wood or plastic plugs are not acceptable.
- Fasteners which cause spalling or cracking of materials to which anchorage is made are not acceptable.
- Explosive actuated fastening devices are not permitted.
- Bolting shall be corrosion resistant and compatible with mating materials.
- Bolts shall project approx. one diameter beyond nuts.
- Washers: plain washers on equipment and sheet metal, Soft gaskets: include lock type washers where vibration occurs.

2.3. Electric Motors

- Motors shall be manufactured and shop tested in accordance with EEMAC standards and shall be CSA approved. Unless otherwise specified, they shall be of the squirrel cage induction type designed for full-voltage or reduced-voltage starting where noted.
- They shall be of the 'premium efficiency' type and all-copper wired.
- In general, motors shall be Design B for continuous operation.
- Unless otherwise indicated, motors shall be open drip proof (ODP) type with Class B or better insulated windings and have a 1.15 service factor. Each motor shall have a small drain hole to relieve condensation build-up.
- Bearings shall be of heavy-duty anti-friction type, and shall be of liberal size for continuous service without overheating. They shall be with suitable shaft seals and grease nipples, and provisions for the exclusion of dust, grit, and other foreign material. Adequate thrust bearing capacity shall be provided for the rotating members.
- Diagonally split, industry approved, sealed type terminal boxes shall be provided together with conduit fittings.
- Motors for 3 phase, 208V service shall be designed specifically for the permissible voltage range. Re-name plated 240V motors are not acceptable.

2.4. Belt Drives

- Fit reinforced belts in sheave matched to drive. Multiple belts shall be a matched set.
- Use cast-iron or steel sheaves secured to shafts with removable keys, unless otherwise specified.
- For motors 10 HP and under, provide standard adjustable-pitch sheaves having 10% adjustment range. Use mid-position of range for specified RPM.

- For motors above 10 HP, provide sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- Minimum drive rating: 115% of motor nameplate rating. Keep overhung loads within manufacturer's design requirements on prime-mover shafts.
- Motor slide-rail adjustment plates to allow centre-line adjustments.
- Tension belts to manufacturer's recommendations before start-up, and then after first 100 hours of running.

2.5. Electrical Work

- In general, electrical work provided under Division 15 in equipment, packages, etc., shall conform to Division 16.
- Mechanical Division 15 shall provide all motor starters and associated controls required and as scheduled on drawings and noted for Division 15 equipment. All starters, drives, contactors, thermal overloads, etc. must be EEMAC rated. All starters shall be of one Manufacturer except as specifically approved otherwise for integral pre-wired assemblies.

2.6. Equipment Access

- Equipment shall be installed to permit equipment maintenance and disassembly with minimum disturbance to connecting piping and ducting systems, and without interference from building structure or other equipment.
- The equipment shall be installed to provide means of lubrication.

2.7. Lubricants

- Lubricants shall conform to equipment manufacturer's recommended type and grade for each individual item of equipment, and for the applicable ambient conditions.

2.8. Instruments and Gauges

- Provide instruments calibrated in Imperial units, as follows:

<u>Parameter</u>	<u>Unit</u>
Pressure (piping, etc.)	PSIG
Pressure (tank level, pump head, etc.)	Feet
Vacuum and pressure (fans, etc.)	Inches WC
Temperature	°F

- Provide 1/4" pipe connections and isolation valves under pressure gauges.
- Unless otherwise indicated, install pressure & temperature indicators as shown on the Drawings.

2.9. Special Tools and Spare Parts

- Furnish all special tools required for maintenance of equipment and systems.
- Provide spare parts list for each item of equipment.
- Supply spare parts where specified with equipment.

2.10. Equipment Nameplates

- Equipment shall be provided with manufacturer's nameplate, in addition to equipment tags previously specified.
- Manufacturer's nameplate shall generally carry manufacturer's name, size and model number, date of manufacture, serial number and registration number. This shall include performance rating, drive motor data, and other pertinent information required by Codes, for the application.

2.11. Access Doors

- Supply access doors to mechanical equipment for operating, inspecting and servicing.
- Access doors: flush mounted 24" x 24" for body entry, and 12" x 12" for hand entry, unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps, unless otherwise indicated.

3.0 Execution

3.1. Examining Conditions

- Examine existing conditions in all work areas in accordance with requirements of Division 1.

3.2. Equipment Installation

- Unless otherwise indicated by the Consultant, install all equipment as instructed by the respective Supplier.
- Assembly: Unless otherwise directed by the Consultant, proprietary equipment shall be assembled and installed in accordance with the Supplier's instructions. Refer to Vendor drawings, instructions, and manuals prior to the assembly and installation of equipment.
- Levelling: All equipment shall be levelled and set by surveying instruments. Set and shim all mechanical equipment bearing plates, level and at the correct elevation.
- Mounting: Unless otherwise indicated by the Supplier, install equipment mounted on a common base as a complete single unit.

3.3. Pipe and Fitting Installation

3.3.1. General

- Use pipe and fittings which conform to CSA Ontario Plumbing Code, CSA B31 Building Services Piping, CSA B149.1 Natural Gas and Propane Installation Code, CSA B52 Mechanical Refrigeration Code and ASTM standards. Pipes and fittings manufactured outside of Canada and USA shall have CSA certification of compliance to all applicable Canadian and USA Standards and Codes.
- Reject damaged pipe and fittings, and pipe and fittings which do not comply with these Specifications.
- Pipes and fittings shall be inspected for soundness, and cleaned of dirt and other foreign matter, before being installed.
- Ream all piping and keep plugged to prevent entry of dirt.
- Make proper allowance for thermal expansion and contraction. Erect piping and equipment in such a manner to prevent undue stress or strain in piping system or equipment connections.
- Where dissimilar metals are connected, each such connection shall be made with a dielectric union or fitting acceptable to the Consultant. Install dielectric couplings or insulated flanges at all connections to underground piping where specified.
- Pipe and tubing shall be free from surface damage.
- Lay copper tubing so that it is not in contact with dissimilar metal, kinked, or capable of becoming collapsed.
- Install piping straight, parallel, and close to walls and ceilings, and at required slopes. Use standard fittings for direction changes.
- Install groups of piping parallel to each other, space to permit application of insulation, identification, and service access.
- Install eccentric reducers in horizontal piping to permit drainage and eliminate air pockets.
- Where pipe sizes differ from connections, sizes of equipment, install reducing fittings close to equipment.
- Install flanges, or unions, and isolating valves to permit removal of equipment without disturbing piping system.
- Clean ends of pipes, tubing, and recesses of fittings, which are to be brazed and soldered. Assemble joints without binding.

3.3.2. Pipe Connections

- Unions or flanges shall be installed on all lines connecting to equipment and controls to facilitate replacement, except where otherwise specified or shown.

3.3.3. Welded Joints

- All welding shall be carried out using only accepted procedures for the class of material being fabricated.
- All welding procedures used shall be fully demonstrated and approved by the regulating authorities.
- The Contractor shall assure that all welders and welding operators are re-qualified at periods not in excess of those required by applicable Codes.
- The Contractor shall be required to provide certificates of personnel to show they are fully qualified to carry out the procedures being used.
- Thoroughly clean the inside of fittings, and outside of pipe, with steel wool, and coat with flux before soldering any copper pipework joint. Remove the working parts of valves before soldering commences and replace after soldering is complete.
- Place valves and specialties to permit easy operation and access. Ensure that valves have been regulated and packed, and have been verified at the completion of the work and before final acceptance. Should leaks develop in the various systems after they have been placed into operation, repair same, and if damage occurs to the building structure, be responsible for repairing same. Costs associated with such repairs shall be borne by Division 15.

3.3.4. Flanged Joints

Unless otherwise specified, flanged joints on steel pipe shall be made with welded slip-on (or weldneck) forged steel flanges; or ductile-iron pipe, with standard screwed companion flanges to suit the service; together with bolts and gaskets, suitable for the application.

3.3.5. Threaded Joints

- Make threaded joints with 'Teflon' tape, unless otherwise specified.
- Apply threaded joint compound, where specified, to the male threads only, and exercise care to prevent the compound from reaching the interior of the piping or fittings. To avoid threading into pipe walls, use 'thread-o-lets'.
- Coat exposed threads on finished joint with rust preventative primer.

3.3.6. Fittings

- Use manufactured fittings, except where fabricated fittings are specified.
- Long radius elbows shall be used where shown or required.

- Mitred joints are not permitted.
- Welded fittings shall be used in all piping where welded joints and fittings are specified, except that 'T' and 'Y' branches smaller than the diameter of the main may be welded directly into the main, unless otherwise indicated.

3.3.7. Pipe Testing

- The Contractor shall provide all necessary equipment and perform all work for the test program, and for testing, locating, remedying leaks and retesting as required. Isolate all controls and instrumentation prior to pressure test. Where new piping is connected to existing system, isolate existing portions of system prior to pressure test.
- Test all pressure piping as follows:
 - Natural Gas: To code requirement.
 - Domestic Water: 75 psig or maximum component design working pressure
- Provide TSSA field refrigerant piping design registration and inspection where required. Follow industry standard for pressure test, evacuation and charging.
- Test all 'gravity' piping under the maximum possible water head as established by the height of stand pipe, etc. Under such conditions, ensure there are no visible or measured leaks. For the test, suitably block the lower end of the piping.

3.4. Location of Instruments, Gauges, and Controls

- Locate instrument and gauges for reading from floor or platforms.
- Where direct reading instruments cannot be properly installed, advise the Consultant before purchase so that remote reading instruments may be substituted, reviewed, and located adjacent to point of reading on wall or structure.

3.5. Flashings

- Where ducts, piping and conduits pass through roof, provide suitable roof cones, curbs and flashing. Supply and install approved counter flashing of same material as flashing.
- Where equipment is roof mounted, this Section will provide suitable approved curbs and bases properly flashed and sealed to roof unless otherwise noted.
- Where plumbing vents and stacks, boiler stacks, or other pipes pass through roof, provide flashings complete with necessary insulation.

3.6. Hangers

- Provide supports, racks, hangers, stands, and platforms, etc., for the proper installation of the Work. Provide all necessary inserts, hold-down bolts, etc.
- Construct all supports to carry the load under all operating conditions and testing.
- Set all hanger rods vertical without bends or offsets. Connect hanger rods to the structure using acceptable inserts and beam clamps.
- Beam clamps, channel clamps, and clamps for attachment to angles shall be complete with a restraining feature. 'C' clamps without restraining features shall not be accepted.
- Unless otherwise noted, all hanger and supports shall be carbon steel construction, adjustable for proper slope.
- Unless otherwise noted, hanger rods shall have continuous threading, such as Anvil Fig. 146 or Myatt Fig. 434. Use locking nuts.
- Unless otherwise indicated, all hangers, supports and threaded rod shall be plated finish for indoors and galvanized finish for outdoors. Touch up all open or cut ends on exterior supports with cold galvanizing compound.
- Adjust hangers so that pipes and ducts will be true in respect of alignment and grade. Ensure that load on building structure does not exceed maximum mechanical loading. Take special care to avoid introduction of undue reaction forces into structure of building.
- Where structural bearings do not exist, supply and install auxiliary angle or channel iron of sufficient size from other structural bearings to support hangers or equipment. Do not hang from steel decking.
- Do not use wire, chain, strap or extension bar hangers under any circumstances.
- Do not use percussion type fastenings of any kind without prior approval in writing.
- Install all work supported from hangers or supports in a manner to ensure that building construction is not weakened or over-stressed, that pipes and ducts are secure, vibration free, free to expand and contract and properly graded, and that vertical adjustment of horizontal pipes and ducts is possible after erection.
- Support all hangers directly from building structure only. Do not support pipes, ducts or equipment from other pipes, ducts or equipment.
- Support plumbing piping in accordance with more stringent requirements of Plumbing Code or these specifications.
- Where hangers are grouped, locate spacing by smallest size pipe. Do not use trapeze type hangers unless specifically shown. Where trapeze

hangers are used, fit insulated piping with insulation shields banded to insulation.

- Support through vertical piping with riser clamps at each floor level or maximum per table below. Secure small vertical piping with long ring stays.
- On copper piping, supply and install approved separation to ensure no contact between copper and hanger of other material. Supply and install barrier to prevent copper pipe being in contact with ferrous or cinder materials.
- Affix threaded hanger rods to building structure by anchors into concrete and by beam clamps on to structural steel work.
- Support piping on walls with offset wall hooks or pipe stays fastened to wall with toggle bolts for small lines or concrete anchors.
- Hangers shall be arranged so as to load structural steel in a concentric manner. Loads shall be imparted either on joist panel points or within 6" of panel joint.
- Drill Anchors may be used to attach to existing structure sized to suit load with 5 to 1 safety factor.
- All pipe hanger rods shall be threaded rod and double-nutted at both ends. All steel piping shall be supported with the following minimum hanger rod diameter at the following maximum spans:

Nominal Pipe Diameter (inches)	Maximum Horizontal Span (feet)	Maximum Vertical Riser Span (feet)	Minimum Rod Diameter (inches)
3/8	4	4	3/8
1/2	6	6	3/8
3/4	6	6	3/8
1	7	7	3/8
1-1/4	8	8	3/8
1-1/2	9	9	3/8
2	10	10	3/8
2-1/2	11	11	1/2
3	12	12	1/2
4-6	14	14	3/4
8	19	19	1
10 -12	20	20	1

3.7. Painting

- Unless otherwise specified, the painting of exposed equipment, piping, supports, etc., shall comprise of two (2) coats of epoxy enamel on properly prepared surfaces. For piping paint colour, follow ASME A13.1 Scheme for Identification of Piping Systems.
- Special finishes for items will take precedence over this Section.
- Touch-up all damaged primed and finish painted items.
- Remove and clean up any over painted surfaces or spilled paint, touch-up any missed or scraped painted surfaces.

3.8. Identification of Equipment

- Nameplates: Do not apply insulation or paint over nameplates. Locate nameplates so that they are easily read. Install nameplates for system designation as specified.
- System Nameplates: Fasten nameplates securely in conspicuous place.
- Tagging Instructions: All items shall be tagged as specified. The tag number must be attached to the equipment supplied and must be shown on each document submitted either for review or information.

3.9. Identification of Ductwork

- Identify ductwork in each area of the building that the ductwork serves.
- Identify system, zone, and air flow direction. Letters shall be black, 2" high.
- Identify ductwork in areas served, at 40ft intervals, and once in each space.

3.10. Identification of Piping

- Identify all piping with service name and flow directional arrows using Brady, Seton, Marking Services or equal self-adhesive pipe markers. Painted stencil markings are not acceptable.
- Encircle piping with directional arrow bands over the ends of pipe marker as to permanently fasten pipe identification.
- Locate pipe identification at the following locations:
 - Behind each access door,
 - At changes of piping direction,
 - At intervals of 40ft in straight runs of piping; and once in each space.
- Pipe identification colours, marker size and letter heights shall follow ASME A13.1 Scheme for Identification of Piping Systems and the general guidelines below. Contact the Consultant where clarification is required.

Pipe Marker Legend	Marker Abbreviation	Marker Primary Colour
Domestic Cold Water	DCW	Green
Domestic Hot Water	DHW	Green
Hot Glycol Supply	HGS	Green
Hot Glycol Return	HGR	Green
Hot Water Supply	HWS	Green
Hot Water Return	HWR	Green
Storm Sewer, Drain	STORM	Green
Sanitary Sewer, Drain	SANITARY	Green
Steam	STEAM	Green
Refrigerant	REFRIGERANT	Green
Natural Gas	NG	Yellow

3.11. Testing, Start-up, Commissioning and Training

3.11.1. General

- Comply with the test requirements that follow. If tests are specified in other sections, or data sheets conflict with these Specifications, the more stringent requirement shall apply.

3.11.2. Test Requirements

- Do not insulate or otherwise conceal work until tests are complete and reviewed. Follow construction schedule and arrange for tests on parts of system as agreed with agency having jurisdictions, and the Consultant.
- Provide temporary blanks at equipment and appurtenances prior to pressure tests on ducting and piping systems. Temporarily remove, or blank-off, all instruments and vulnerable items during pressure testing.
- Provide adequate restraints over the duration of the pressure tests in the ducting and piping systems.

3.11.3. System Tests

- Balance and adjust ducting and piping systems. Provide fluid flow balance and flow reports for systems.
- Demonstrate the operation of all ducting, piping and equipment.
- The tests shall be carried out to ensure operation is in compliance with the Specifications.

3.11.4. Start-Up, Commissioning and Training

- Provide all personnel required for equipment start-up, plant commissioning and Owner training.

End of Section

Table of Contents

1.0 General..... 1
 1.1. Scope 1
 1.2. Related Work Specified Elsewhere 1
 1.3. Requirements of Regulatory Agencies 2
 1.4. References 2
2.0 Products 2
 2.1. Packaged Rooftop Heating/Cooling Units (AC-2,3,4,5,6)..... 2
 2.2. Ducting 3
 2.3. Ducting Accessories 4
 2.4. Piping 5
 2.5. Radiant Tube Heaters 5
3.0 Execution..... 9
 3.1. Rooftop HVAC Units..... 9
 3.2. Ducting 10

1.0 General

1.1. Scope

Under this section, the Contractor shall replace various HVAC equipment and make modifications to existing air distribution systems to accommodate interior renovations, complete in all respects including the following main items:

- Remove and dispose of five (5) existing rooftop packaged heating/cooling units AC-2, 3, 4, 5, 6 as shown on drawings.
- Remove and dispose of two (2) Apparatus Bay ceiling hung hydronic unit heaters including piping as shown on drawings. Install insulation valves at the limits of pipe demolition to allow the system to continue to operate until the future hydronic system renovation/removal.
- Remove and dispose of two (2) existing gas fired radiant tube heaters as shown on plans.
- Furnish and install five (5) new rooftop packaged heating/cooling units AC-2, 3, 4, 5, 6 on new curb adapters as shown on drawings.
- Reconnect existing gas lines to new units and provide new condensate drains.
- Reconnect existing supply and return air ducts to new rooftop units. Include new transition pieces as required to accommodate addition of the curb adapters and new rooftop unit configuration.
- Control of new and existing rooftop units shall be assumed by the new BAS.
- Roofwork at new rooftop units as shown on Building Envelope drawings.
- Furnish and install two (2) new gas fired radiant tube heaters including extension of gas piping to furthest heater and new double wall B vents through roof.
- New 12" round vent through west wall of Apparatus Bay complete with exterior hooded wall vent. Include relocation of existing services as required to accommodate the new position of the Drying Cabinet.
- Relocate existing supply air diffuser in ground floor Reception area.
- New supply air diffuser in ground floor Office complete with flex duct connection to existing main duct and balancing damper.
- Air balancing for new rooftop units AC-2, 3, 4, 5 and 6.
- Permits and inspections as required.
- Startup, commissioning and verification of all new equipment.
- One year warranty on all materials and quality of work.

1.2. Related Work Specified Elsewhere

Each section of the specifications and drawings is not necessarily complete in itself and all sections of the specifications and drawings are related. The Contractor shall read each section in conjunction with all of the other Contract

Documents. The Contractor shall also ensure that all Subcontractors read the relevant documents and comply with the requirements.

- Division 1 General Requirements
- Division 2 Site Construction
- Division 15 Mechanical
- Division 16 Electrical

1.3. Requirements of Regulatory Agencies

All work shall conform to regulations of Municipality, Province, and Country in which the project is to be constructed.

1.4. References

- SMACNA: HVAC Duct Construction Standards, Metal and Flexible
- SMACNA: HVAC Duct Leakage Test Manual
- ASHRAE Handbooks: Fundamentals, HVAC Systems and Applications
- ASTM A 525M, Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
- ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating System
- ANSI/NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems

2.0 Products

2.1. Packaged Rooftop Heating/Cooling Units (AC-2,3,4,5,6)

- Furnish and install five (5) new packaged rooftop heating/cooling units (natural gas), electric cooling and ventilating units in sizes as detailed in the equipment schedules.
- Each unit: A complete package, factory tested, manufactured in compliance with ASHRAE 90.1-2010 and operable after completion of wiring, ductwork and natural gas connections.
- Mount new rooftop units on existing roof curbs using manufacturer's curb adapters.
- Reconnect existing gas and power to new rooftop units including new weatherproof disconnect and gas isolation valve.
- Install new PVC condensate drains.
- Control of new rooftop units shall be incorporated into the new Building Automation System. Coordinate rooftop units control features with BAS contractor.

2.2. Ducting

2.2.1. General Ducting

- Rectangular and round spiral ducting shall be low-pressure, metallic type for pressures to 2" wc.

2.2.2. Materials

- Unless otherwise indicated, ducts and fittings shall be of G-90 galvanized steel in accordance with ASTM A-653 and A-924.

2.2.3. Construction

- Fabrication: to ASHRAE and SMACNA standards.
- Radiused elbows: up to 16", using single-thickness vanes.
- Square elbows: up to 16", using single-thickness vanes.
- Square elbows: above 16", using double-thickness turning vanes.
- Round spiral ducts: smooth inner surface, with factory-fabricated fittings.
- Balancing dampers: provide for main ducts & branch ducts.
- Diverging transitions: 20° maximum included angle.
- Converging transitions: 30° maximum included angle.
- Offsets: square elbows, or full-radiused elbows.
- Obstruction deflectors: maintain full cross-sectional area. Maximum included angles as for transitions.

2.2.4. Joints

- Lock forming quality: to ASTM A525M, Z90 zinc coating.
- Thickness: to ASHRAE and SMACNA standards.
- Fabrication: to ASHRAE and SMACNA standards.
- Reinforcement: to ASHRAE and SMACNA standards.
- Joints: to ASHARE and SMACNA standards, or proprietary manufactured duct joint.
- Flanged duct joint shall be a Class A seal as identified previously.
- Acceptable Suppliers: Ductmate Can.; Exanno Nexus or equivalent.

2.2.5. Sealing

<u>Pressure (max)</u>	<u>SMACNA Seal Class</u>
2" wc	A
1"wc	B
1/2" wc	C
1/4" wc	Unsealed

- Seal Class A: Longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant.
- Class B: Longitudinal seams, transverse joints and connections made airtight with sealant.
- Class C: Transverse joints and connections made airtight with sealant. Longitudinal seams unsealed.
- Unsealed: Unsealed seamed and joints.
- Unless otherwise indicated, SMACNA Seal Class A shall be used for ductwork.

2.2.6. Sealant

- Sealant: oil resistant, polymer type, flame resistant duct sealant, suitable for a temperature range of -22°F to 200°F.
- Acceptable Supplier: Duro Dyne S-2; Foster 30-0; or equivalent.

2.2.7. Fire-Stopping

- Retaining angles all around duct, on both sides of fire separation.
- Fire-stopping material and installation shall not distort duct.

2.2.8. Hangers and Supports

- Hanger and support configuration: to ASHRAE and SMACNA standards.
- Type and Sizes: as indicated on the drawings

2.3. Ducting Accessories

2.3.1. Flexible Connectors

- Frame: galvanized sheet metal frame 0.050" thick, with fabric clenched double locked seams.
- Material: fire resistant, self extinguishing, neoprene-coated glass fabric; temperature rated at -40°F to +200°F; density of 0.08 lb/ft³.

2.3.2. Turning Vanes

- Shop fabricated, single thickness and double thickness as previously noted, and in accordance with SMACNA recommendations.

2.3.3. Instrument Test Ports

- 0.063" thick steel, zinc plated after fabrication.
- Cam lock handles with neoprene expansion plug and handle chain.
- 1" inside diameter; length to suit insulation thickness.
- Neoprene mounting gasket.
- Acceptable Suppliers: Duro-Dyne (IP 1 or IP2); or equivalent.

2.4. Piping

2.4.1. Condensate Drain Piping

- Pipe and Fittings: Sch. 80 PVC
- Connections: solvent weld (threaded only where necessary)

2.4.2. Natural Gas Piping

- Pipe: Sch. 40 steel to ASTM A53B ERW or A106B SMLSS.
- Connections: welded for 2 ½" diameter and above with flanges at equipment and valves; screwed for 2" diameter and below.
- Fittings: 150 lb forged steel butt or socket welded to ANSI A234B; 150 lb screwed forged steel or malleable iron to ANSI B16.3.

2.5. Radiant Tube Heaters

2.5.1. General

- Site assembled, modular infrared radiant heating unit for overhead mounted space or area heating application.
- Supplied with the heater as required for field installation and start-up will be a burner with all necessary factory installed wiring, piping, and controls and a radiant tube/reflector system, complete with hangers and end plates, corresponding in length to the burner input.
- The radiant tube type infrared heating unit(s) will be manufactured by Schwank.
- Heater size(s) and capacity(s) are as noted on drawing and/or schedule

2.5.2. Emitting Tube System

- All tubes will be 4" diameter with an emitting surface area of 152 in² per linear foot
- For inputs up to and including 155,000 Btuh the 10 ft combustion tube adjoining to the burner will be constructed of 16 gauge aluminized steel
- The system tubes will have a swage of approximately 4" in length to accommodate the connection of subsequent tubes and vent pipe at the heater termination
- Each tube connection in the system will be secured in place with a 4" coupler

2.5.3. Reflector Shield System

- Reflector shields will be constructed of high grade steel with a heat and corrosion resistant hot-bonded aluminum-silicon alloy coating.

- The reflector system will enclose the emitting tube system on the top and two sides and extend to the bottom surface of the tube system to entrap convection heat around the tube system, thereby increasing overall tube temperature and infrared heat emission.
- The reflector system will have an aluminized-steel sheet metal end cap at each end of the system and at each juncture with an elbow to minimize the escape of entrapped convection heat and reduce clearance to combustibles above the heater.

2.5.4. Tube/Reflector Suspension System

- The tube/reflector system will have ¼" galvanized steel wire hangers at each side of a tube connection that will serve to support the reflector/tube system, and allow the free passage of entrapped convection heat along the length of the system to produce more uniform heat from end to end
- The tube/reflector hangers will enable suspension of the system so that the reflector shields can be oriented about the long axis of the system at a fixed angle between 0° to 45° as indicated on the drawings
- The entire tube/reflector system will be suspended from the structure as indicated in the Installation and Owner's Manual or as specified in the drawings and/or schedule

2.5.5. Burner

- The burner will utilize a burner cup with an 'effect' ceramic tile at its outlet to ensure a homogenous gas/air mixture and high velocity flow of the gas/air mixture exiting the burner.
- The burner will use coaxial flow control elements and high velocity flow of the gas/air mixture to create a very long, laminar and axially straight flame that will produce higher tube temperature and optimum temperature uniformity incrementally along the tube length. The flame will have a minimum length of 6 ft at 60,000 Btuh input and will be 14 ft in length at 200,000 Btuh input.
- The burner will have a blower to create a positive pressure in the tube system
- The blower will provide combustion air flow directly to the burner assembly so that electronic burner components are isolated from the air flow
- The burner will operate on either natural gas or propane gas
- The burner will be housed in a pre-painted sheet metal protective cabinet
- The burner cabinet will be of a 'clam-shell' design that opens downward on a hinge to provide service access to all burner components
- The burner will be able to operate with the housing cabinet in the 'open' service position
- The burner can be fitted with an optional 4 inch diameter collar at the blower inlet in case site conditions warrant connection of outside combustion air

2.5.6. Gas Supply

- The gas supply will be connected to the heater using a flexible gas connection of the type and in a manner that is prescribed by national and/or local codes

2.5.7. Controls and Safeties

- Electrical Rating: The burner will operate on a 115 VAC, 60Hz electrical supply with a current rating of no less than 1.5A at 115 VAC
- Heater gas and ignition controls will be readily accessible for servicing.
- The burner will have solid state direct spark ignition and flame sensor control that is dedicated to secure the operation of the burner

2.5.8. Ignition and Flame Control

- To complete the direct spark ignition system the burner will incorporate a two stage gas control with low stage at a 30% reduction from high stage
- Burner will be complete with a 24 VAC transformer, a low voltage (24 VAC) solid state direct spark ignition and ionization flame sensing control module that will provide a 30 second pre-ignition purge of the system by the blower. Electrical Rating: 24 VAC, 60Hz with current rating of 0.2A at 24 VAC
- Burner will be complete with an igniter/sensor to provide spark ignition and flame sensing. The igniter/sensor will be installed on site into a port manufactured in the first tube adjacent to the burner.
- The ionization module will sense the presence of main burner flame and discontinue spark ignition. If the burner fails to ignite within the trial-for-ignition period, the flame control will go into safety lockout. Reset of the control is manually done from the thermostat.
- The ionization module will check for a false flame condition (short to ground) and lock out if a false flame condition is present.
- The ignition module will have a total 21 second trial-for-ignition period
- The ignition module will open the main gas valve and generate 30,000 volts at the spark igniter for direct ignition of the burner.
- On a loss of burner flame the timed trial-for-ignition is repeated. Safety lockout occurs if flame is not reestablished within the total 21 second trial-for-ignition period. Reset of the control is accomplished manually from the thermostat or electrical supply.

2.5.9. Gas Control

- Heater will be complete with a two stage gas control with a manual valve, two automatic operators, and a pressure regulator
- Electrical Rating: 24 VAC, 60Hz; draw 0.5A with both operators energized
- Depending upon call from the control system, the gas control will provide gas input to the heater at either a high fire rate or at a low fire rate that is a 30% reduction of the high fire rate
- The gas control will have an inlet pressure tap and an outlet pressure tap to facilitate measurement of gas supply and manifold pressures during servicing.
- Heater will be complete with a ½” pipe nipple for connection to the gas supply;

2.5.10. Heater Temperature Control

- Burner will be complete with a 24/120 VAC relay switch;
- Space Heating: Heaters will be controlled using new Building Automation System. The new heaters shall be zoned with one existing heater. Refer to BAS drawings.

2.5.11. Safety Controls

- Burner will be complete with a pressure switch in the ignition system electrical circuit that will close upon proving a sufficient supply of combustion air from the blower
- Burner will further be complete with a separate pressure switch in the ignition system electrical circuit that will open upon pressure resulting from a blocked flue condition in the tube system

2.5.12. Exhaust Requirements

- Direct Vented gas fired infrared heating system installation will comply with the manufacturer’s installation instructions, the current National Natural Gas and Propane Installation Code and all applicable local codes using a 4” vent pipe of a gauge prescribed by national and/or local codes
- Gas fired infrared radiant heating system installation will comply with the manufacturer’s installation instructions, the current national Natural Gas and Propane Installation Code B149.1 and all applicable local codes.

2.5.13. Electrical Requirements

- Power supply wiring (115 VAC, 60Hz, with a current rating of no less than 1.5A at 115 VAC) will connect to the heater as per the wiring diagram in the manual supplied by the manufacturer.

3.0 Execution

3.1. Rooftop HVAC Units

- Install HVAC units and ship loose accessories in accordance with manufacturers' installation literature.
- Coordinate installation with structural, roofing and slab on grade work. Provide temporary weatherproof cover for all building openings created by demolition and removals as required.
- Coordinate with facility schedule for down times of areas served by these units during the renovation.
- Provide new ducting, duct transitions and flexible duct connections where required.
- Provide new manufacturer's 14" high roof curbs.
- Provide new PVC condensate traps.
- Provide new gas isolation ball valves and piping connection with drip leg and union at new units.
- Clamp all new piping to new moulded plastic pipe support blocks with Styrofoam underlay.

3.2. Gas Fired Radiant Heaters

- Install as shown on plans and according to manufacturer's recommendations.
- Review existing site conditions for conformity to manufacturer's requirements and advise Owner and Consultant of any conflicts.
- Include manufacturer's seismic restraint chains and any supplemental steel or anchor points as required.
- Run new double wall B vent through existing openings and seal as shown on Building Envelope drawings.
- Test and commission.

3.3. Ducting

3.3.1. General

- All work shall be in accordance with ASHRAE and SMACNA standards, conforming to all local codes.
- Support risers in accordance with ASHRAE and SMACNA standards.
- Install break-away joints in ductwork on each side of a fire separation.
- Install flanged duct joints in accordance with Supplier's instructions.
- Install all transitions with a flat surface on top.

3.3.2. Hangers and Supports

- Install in accordance with SMACNA standards.
- Fasteners: complete with locking-nuts and washers.
- Supports shall be located near every termination, direction change and riser. Spacing along runs as follows:

<u>Duct Size</u> <u>Equivalent Dia.</u> <u>(in)</u>	<u>Spacing (ft)</u>
Up to 60"	10'
Over 60"	8'

3.3.3. Turning vanes

- Install in accordance with recommendations of SMACNA.

3.3.4. Sealing

- Apply sealant to outside of joint in accordance with the Supplier's recommendations.

3.3.5. Testing and Balancing of Air Distribution Systems

- Conduct testing and balancing for air distribution systems served by AC-2,3,4,5,6.
- The extent of existing balancing dampers on the systems is unknown. The balancer shall note where the addition of balancing dampers is required to achieve target air flows.
- Refer to drawings for TAB schedule showing areas served by equipment and terminal counts. Where available, existing air distribution system drawings will be available to successful contractor.
- Upon completion, a written report shall be provided to the consultant.

End of Section

Table of Contents

1.0	General.....	1
1.1.	Overview	1
1.2.	Scope	1
1.3.	Related Sections	2
1.4.	Standards and References.....	2
1.5.	Submittals.....	2
1.6.	Warranty.....	3
2.0	Products	3
2.1.	Approved Vendors.....	3
2.2.	Hardware.....	3
2.3.	Software	3
2.4.	Graphics	4
2.5.	Wiring	4
3.0	Execution.....	4
3.1.	Installation	4
3.2.	Testing and Commissioning	5
3.3.	Training	5

1.0 General

1.1. Overview

The facility renovations at Fire Station #1 include the installation of a new Building Automation System. Current control consists of various stand alone systems and the control strategies presently utilized for HVAC equipment control shall be duplicated unless indicated differently on plans.

There is a new generator monitoring panel located in the basement electrical room and the new BAS shall incorporate this panel. Refer to drawings for the BAS schedules, control setting and sequence of operation.

All BAS work shall be by Vendors specified. The BAS subcontractor shall examine the existing system prior to bidding and installation.

1.2. Scope

Under this section, the BAS contractor shall design furnish and commission and satisfactorily operate the new Building Automation System complete in all respects to the full intent of the drawings and specifications, including the following functionality:

- Rooftop Units AC-1,2,3,4,5,6, existing electric duct heaters and bypass boxes (All rooftops but AC-1 are being replaced as part of this project, ductwork and registers to remain with only minor modifications made to AC-2 registers).
- New bypass box actuators
- Apparatus Bay Gas Fired Infrared Heaters zoned as shown on plans. The two western most radiant heaters are to be replaced as part of the project.
- Garage HVAC equipment including exhaust fan, fresh air louvers, electric heater and hydronic heater.
- Monitoring of Hot Water Heater and Recirculation Pump located in basement mechanical room.
- Additional temperature sensors to be used for monitoring in areas such as washrooms and stairwells. These sensors shall be utilized for control in the future when the hydronic loop is removed and/or renovated.
- Noxious gas sensors in the Apparatus Bay.
- Outdoor ambient air condition sensors.
- Provide BAS panels with UPS to allow operation through power interruptions.
- Provide sensors, transducers, CT's, relays, labelled equipment switches with pilot lights where indicated, equipment electrical interlock wiring and low voltage wiring.

- Furnish and install low voltage power supplies for new BAS devices as required. The contractor shall locate spare breakers in existing lighting panels and install and label transformers as required.
- Work shall be staged and sequenced, switching over one unit at a time before proceeding to the next. Provide panel, controls and wiring installation, programming, graphics in advance of equipment tie-ins to minimize down time.
- Test and commission controls and new BAS components and verify proper control of all new and existing equipment.
- Co-ordinate with Testing and Balancing contractor to operate equipment while performing air flow tests.
- Cutting and patching of openings as required to complete the installation.
- Permits and inspections as required.
- Facility training. Coordinate with the Consultant, Owner and facility staff.
- Close-out documentation including O&M manuals and As-Built drawings.

1.3. Related Sections

Each section of the specifications and drawings is not necessarily complete in itself and all sections of the specifications and drawings are related. The Contractor shall read each section in conjunction with all of the other Contract Documents. The Contractor shall also ensure that all Subcontractors read the relevant documents and comply with the requirements.

- Division 1 General Requirements
- Division 2 Site Construction
- Division 15 Mechanical
- Division 16 Electrical

1.4. Standards and References

- OESC, Ontario Electrical Safety Code.
- ESA, Electrical Safety Authority.
- Regulations of authorities having jurisdiction.

1.5. Submittals

- BAS shop drawings including network details, schematics, control strategies and points list.
- BAS panels, hardware, software, controls, sensors and accessories. Clearly indicate model number and options on all shop drawings and data sheets.

1.6. Warranty

- The warranty shall cover all costs of material, labour, travel and expenses for one (1) year from date of start of substantial performance.
- Reliable Controls equipment five (5) year manufacturer warranty.
- Personnel supporting the warranty agreement shall provide on-site or off-site service in a timely manner after notification of a problem to the Vendor. The maximum response time to provide this on-site service shall be 24 hours on weekdays and 48 hours on weekends.

2.0 Products

2.1. Approved Vendors

The Building Automation System shall be comprised of Reliable Controls components. As such, a Reliable Controls authorized dealer shall provide the BAS and associated components, and shall be carried as the BAS Sub-Contractor.

2.2. Hardware

- New modules, transformers, relays and other hardware shall be mounted in BAS panels.
- New modules where required shall be manufactured by approved BAS vendors.
- Sensors and transducers shall suit specified applications and sensing mediums. Provide isolation valves on piping pressure transducers and thermowells on piping temperature transducers.
- Third party device controllers shall be BACnet compliant with BACnet modules as required.

2.3. Software

- Native BACnet software to be completely compatible with the City's server based software.
- Software shall have energy efficient building control strategies including scheduling, optimizing to outside ambient conditions and effect equipment control.
- Software shall reside in hardware and shall not be dependent on operator workstation. Workstation software is for access to all graphic screens for monitoring and setpoint adjustment of space temperatures, scheduling, runtime accumulation, equipment alarm reporting and override timers for after hour usage.

- The software shall have multi-level password login whereby changes in setpoint adjustment ranges require authorization.
- Provide all programming, graphics, trend logging and alarming. Allow for modifications to control sequences under upset conditions such as system operation in a limited function in the event of equipment or component failure.

2.4. Graphics

- Web based graphics to reside on City's server.
- The BAS vendor shall not add their company name to any graphic screens.

2.5. Wiring

- Provide all modifications to existing equipment control wiring and new wiring as required for a complete installation. Provide power for all control components from nearest electrical power source. Co-ordinate with the electrical contractor.
- Provide wiring as recommended by equipment manufacturers, use shielded wiring for all analog signals and CAT cabling for communication wiring.
- Wiring shall be neatly and professionally installed. Run parallel to building lines and tight to roof deck and walls. Provide proper support of all wiring runs. Control wiring shall not be installed near power wiring. Provide auxiliary junction boxes as required.
- Control wiring in occupied areas shall be concealed and installed free-air in accessible ceiling and wall cavities. Control wiring in mechanical rooms shall be run in surface mount EMT conduit with all final equipment connections run in liquidtight. Control wiring outside shall be run in surface mount rigid galvanized steel or liquidtight. Seal all conduits where transitioning from cold to warm areas.

3.0 Execution

3.1. Installation

- Locate BAS panels and I/O modules as required and mount securely, plumb, true and square. Provide wireways where required.
- Connect to panels and controllers following manufacturer's instructions.
- Install all controls, sensors and instrumentation as required. Components shall be easily accessible for service. Mount all controls to protect from vibration or excessive temperatures. Where provided, locate room temperature sensors away from outside walls or where affected by direct sunlight.
- Where provided, room temperature sensors to be mounted not less than 600mm (24 in) and not more than 1200 mm (47 in) above the floor, where there is no obstruction. Where there is an obstruction that is between 500mm (20 in) to 625mm (25 in) in depth, mount room temperature sensors between 600mm

(24 in) and 1100mm (43 in) above the floor. Controls that are used often should be located at 42 in above the floor. There shall be a clear floor area of at least 2200mm (54 in) wide to allow a person using a mobility device to access controls. If clear floor area is not provided, review with consultant to determine acceptable new location for control.

- Identify all panels, components and controls with nameplates.
- Coordinate all work with the Contractor and to suit project and facility schedule.

3.2. Testing and Commissioning

- Upon completion of installation work, calibrate sensors as required and set-up all control parameters. Perform pre-startup testing and confirm the system is ready for commissioning.

3.3. Training

- Upon completion of the work, provide personnel for training session to instruct the facility personnel in the operation of the control system.
- Allow for minor modification of data displays and status descriptors to suit the City and end user preferences.

End of Section

Table of Contents

1.0 General..... 1

1.1. Intent of Section..... 1

1.2. Scope of Electrical Work 2

1.2.1. General Requirements..... 2

1.2.2. Scope of Work 3

1.3. Related Work..... 3

1.4. References, Codes and Standards..... 4

1.5. Field Investigation..... 4

1.6. Materials and Equipment..... 4

1.7. Voltage Ratings 5

1.8. Examination of Site..... 5

1.9. Planning and Layout of Work 5

1.10.Coordination 5

1.11.Protection of Equipment and Materials..... 5

1.12.Penetrations and Seals 6

1.13.Cable and Wire Testing 6

1.14.Permits, Fees, and Inspection 6

1.15.Submittals..... 7

1.16.Record Drawings..... 7

1.17.Operation and Maintenance Instruction Manuals 8

1.18.Clean-up..... 8

1.19.Warranty..... 8

2.0 Products 8

2.1. Materials and Equipment..... 8

2.2. Finishes 9

2.3. Equipment Identification 9

2.4. Nameplates 10

2.4.1. Lighting Panels 10

2.4.2. Power Distribution Panels..... 10

2.5. Wiring, Conduit and Cable Identification..... 11

2.6. Wiring of Systems and Equipment Supplied by Others 11

2.7. Ambient Environment 11

3.0 Execution..... 12

 3.1. On Site Usage and Instructions..... 12

 3.2. Preparation and Protection..... 12

 3.3. Outlet Locations and Conduit Runs..... 14

 3.4. Mounting Heights..... 14

 3.5. Penetration Seals..... 14

 3.6. Hangers and Supports..... 15

 3.7. Cleaning..... 15

 3.8. On-Site Tests..... 16

 3.9. Demonstration and Training..... 16

1.0 General

1.1. Intent of Section

- The Contractor shall provide, not only the equipment, services and products mentioned in the specifications, shown on the drawings, or reasonably implied, but also all the equipment and accessories required as per all applicable codes, standards, and associated bulletins, to provide a complete overall operational system, and place in service when and as directed by the Engineer. The word "provide" means design, supply, install, terminate, commission, and test.
- It is the Contractor's responsibility to refer to all the contract documents, i.e., specifications and drawings to provide a complete overall operational system. Unless otherwise indicated, the drawings and specifications in this tender document are considered to be mutually complimentary and shall be read together.
- In the event of conflicting and/or incorrect information shown on the drawings and/or mentioned in the specifications, or between the information in the contract documents and the applicable codes and standards or equipment incorrectly specified, it shall be the Contractor's responsibility to advise the Engineer in writing of such information, and await their written instructions prior to the submission of tender price. No exceptions shall be granted after the closing of the tender. The Engineer's decision shall be final and binding.
- The Contractor shall be responsible for the review of all the contract drawings, and specifications, as to identify and provide the works required under this division.
- The electrical drawings are performance and diagrammatic drawings, intended to convey the scope of the work and indicate general arrangement, approximate locations and sizes of equipment, working space, access to equipment, outlets, fixtures, etc. and general routing of cables, conduits, wireways, busways and cable bus. Locations of existing services shown are approximate.
- The Contractor shall verify the exact locations, lengths, sizes, and ratings of all affected existing services, cables, conduits, feeder circuit breakers, etc. Notify Engineer of any discrepancy.
- The drawings do not intend to show all the structural, mechanical, and architectural details, and in some cases conduit and/or wiring is shown diagrammatically on drawings which may not detail exact or complete wiring or raceway requirements. Refer to the mechanical and architectural drawings for accurate building dimensions.
- The electrical drawings are not installation drawings and do not show all the required equipment and accessories to provide for a complete working system and as such it shall be agreed that the Contractor shall review the

plans and provide all coordination, all the labour and materials required to provide equipment according to the requirements and intent of the tender documents.

1.2. Scope of Electrical Work

This Section specifies the general requirements of the electrical work associated with the renovations to Peterborough Fire Station #1.

1.2.1. General Requirements

The Work to be done under this Contract, as specified herein and as shown on the Drawings, includes the supply of all products and services mentioned or shown in the Contract Documents with incidentals necessary for a complete operating installation. The Work of the Contract generally consists of, but is not limited to following:

- The Contractor shall provide all labour, materials and equipment necessary to complete all works as shown on the electrical and mechanical drawings and herein specified.
- The Contractor shall provide at no extra costs for all electrical wiring and terminations required for equipment supplied in other Divisions, irrespective of whether or not it is shown or mentioned on the drawings and specifications so as to supply a complete overall working system to operate as specified herein.
- Where special wiring (cables supplied with instruments, etc.) is supplied by other Divisions, this Division shall provide for the installation of all this wiring in co ordination with the Division supplying the said wiring.
- Where spare wiring is installed, all spare wiring shall be identified (tagged) at both ends and shown on record drawings.
- Where equipment is supplied by other Divisions and installed under this Division:
 - The Contractor shall be responsible for the proper installation of all panels, motors, enclosures, switches, etc., as shown on the drawings or specified in the other division specifications.
 - The Contractor shall be responsible for verifying that the equipment's electrical specifications are suitable for the intended application as per Division 1. Check all voltage ratings, wiring terminations, current ratings and other electrical characteristics so as to supply a complete working system to operate as specified herein. All the tests required by the Engineer to confirm the operation of all the systems, as per the contract documents shall be provided by Contractor at no extra cost.

1.2.2. Scope of Work

The work to be carried out by the Contractor shall include, but not be limited to the supply and installation of the following:

- Lockout and tagging as required for equipment replacements.
- Disconnect existing 3/60/230V feeds to rooftop units.
- Verify conductor sizing to rooftops and reconnect to new rooftops including new weatherproof disconnects.
- New breakers for replacement rooftop units as shown on plans.
- Connect 3/60/230V feeds to new rooftop units. Note that new rooftop units will be placed on 14" curb adapters
- New 1/60/120V service receptacles on roof as shown on plans.
- Relocate existing 1/60/120V power feeds from two (2) decommissioned Apparatus Bay radiant heaters to two (2) new Apparatus Bay radiant heaters as required.
- Furnish and install two (2) new circulation fans in the Apparatus Bay as shown on plans.
- Relocate existing 1/60/120V power feeds from two (2) decommissioned Apparatus Bay hydronic heaters to Apparatus Bay circulation fans as required.
- Relocate existing services as required along west Apparatus Bay wall for the installation of the Drying Cabinet.
- Power and control wiring as required to complete mechanical and Building Automation System works including existing equipment removals, reuse and relocation, and new equipment as indicated.
- Grounding and bonding.
- Confirm and remove abandoned existing conduits and wiring as required and where practical.
- Cutting and patching of openings as required to complete installation.
- Permits and inspections as required.
- Startup, commissioning and verification of all new equipment.
- One year warranty on all materials and quality of work.

1.3. Related Work

- Division 16 describes the majority of the electrical work required under this contract. However, additional electrical scope of work is included under other divisions of this contract and shall be provided and/or installed complete under this division. In particular, Division 15 – Mechanical (e.g. HVAC power and controls, etc.), as well as Architectural and Structural. Electrical work included in other divisions will not be necessarily duplicated in division 16 in order to avoid double pricing. The licensed electrical contractor shall not limit their review to only Division 16, but also coordinate with all contractors of all other divisions (and vice versa) and review all

divisions of the specifications and contract drawings of this contract in order to determine the overall complete scope of the electrical work and provide complete electrical functioning systems.

- Steel work that is required solely for the work of electrical trades and not shown on architectural, mechanical or structural drawings shall be provided and installed by this trade.
- Unless otherwise specifically stated, the Contractor shall be responsible for the supply and installation of all power supply wiring and conduits as required for all equipment supplied under this contract.

1.4. References, Codes and Standards

- Equipment and installation provided under this Division shall conform to applicable standards and regulations (latest version) of the following organizations:
 - Canadian Standards Association (CSA).
 - Canadian Electrical Manufacturers Association (CEMA).
 - Electrical and Electronic Manufacturers Association of Canada (EEMAC).
 - National Electrical Manufacturers Association (NEMA).
 - Underwriters' Laboratories of Canada (ULC).
 - Ontario Electrical Safety Code (OESC).
 - Electrical Safety Authority (ESA).
- Where these standards are at variance with each other or with contract document, the more stringent requirement (as selected by the Owner) shall apply.

1.5. Field Investigation

- Existing drawings that detail the wiring configurations are not available. Contractor shall carry out thorough field investigation to determine the configuration of existing wiring, conduits routing, wiring source and destination for work items identified on plans.
- Use ground penetration radar or X-ray to map out the routing of existing concealed conduits in concrete slab.
- Submit documentation showing location of panels, field devices, equipment, conduit size and routing, wire size, wire count, circuit number, etc.

1.6. Materials and Equipment

- Equipment and material must be CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Inspection Department. Pay all associated fees.
- Provide Canadian manufactured equipment and materials, except where specified otherwise or where Canadian made materials or equipment do not exist.

- All overcurrent protection shall be capable of interrupting the available fault current as per Rule 14-012 of the OESC.

1.7. Voltage Ratings

- Operating voltages: to CAN3-C235.
- Motors, electric distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating units established by the above-mentioned standard. Equipment to operate in extreme operating conditions established in above-mentioned standard without damage to equipment.

1.8. Examination of Site

- Visit and examine the site and review the existing drawings and drawings from other trades. Generate a plan for a safe procedure for proceeding the electrical work. No compensation will be considered for difficulties arising from failure to do so.
- Carefully examine all conditions at the site that will or may affect the electrical Work, and become familiar with site conditions, the building construction, finishes, and existing electrical and mechanical (HVAC) control systems in order that the tender price includes for everything necessary for completion of the electrical work.

1.9. Planning and Layout of Work

- The exact locations and routing of electrical devices and cables are to be properly planned, coordinated and established with all affected trades prior to installation.

1.10. Coordination

- The contractor shall coordinate all phases of construction, attend coordination and construction meetings as required and schedule delivery and installation to meet project schedule. Coordinate all work with facility staff and as not to disrupt facility operations.
- All motors associated with mechanical equipment will be supplied and mounted by the section responsible for the respective mechanical work.
- Review the equipment schedules on the mechanical drawings and the equipment specification for special requirements stated therein.
- Unless otherwise indicated, supply and install all disconnecting switches and all other miscellaneous equipment required to completely wire the mechanical systems as part of this Division's work.

1.11. Protection of Equipment and Materials

- Store instrumentation, control panels and other equipment in a dry heated space in accordance with manufacturers' recommendations.

- Properly protect all electrical equipment and materials on site from damage due to the elements, the electrical Work and the Work of other trades, to the satisfaction of the Operating Authority.
- Moving parts to be prevented from any movement to avoid damage during shipment and movement of equipment. Display instructions to remove blocking before putting equipment into service.
- Protect equipment from moisture, dust and damage during storage, shipment and installation.
- Assume full responsibility for receiving, unloading, checking for damage, verification of quantities against shipping documents, storing and protecting all the equipment and materials that are shipped to site. Advise Engineer and appropriate equipment manufacturer of any damage or missing items.

1.12. Penetrations and Seals

- Provide all penetrations required for electrical work. Before proceeding with any core drilling, x-ray floor to avoid any concealed obstructions.
- Install appropriate seals for all walls, floors, ceilings and roof penetrations.

1.13. Cable and Wire Testing

- Test insulation of existing power wiring that will be re-used. Conduct testing prior to re-connecting the power wiring. Notify Engineer immediately if any existing wiring has failed the test.
- Conduct insulation resistance measurements using a "Megger" (500V instrument for circuits up to 350V and 1000V instrument for circuits between 350V and 600V).
- Record test results in a log book and submit to Engineer for reference. Replace or repair circuits which do not meet inspection authority requirements. With equipment disconnected, measure insulation resistance of the following circuits:
 - Power and motor feeders.
 - Phase to phase
 - Phase to ground
 - Control circuits
 - Ground only
- Do not perform "Megger" tests on equipment containing solid state components.
- Disconnect power factor correction capacitors from system prior to testing.

1.14. Permits, Fees, and Inspection

- Notify Electrical Safety Authority (ESA) in sufficient time to inspect work. Provide Inspection Department and Supply Authority any additional

- necessary number of drawings and specifications for examination and approval.
- Notify Contract Administrator of changes required by Electrical Inspection Department before making changes.
 - Furnish Certificates of Acceptance from ESA Inspection Department on completion of work and supply a copy to the Contract Administrator.
 - Pay all associated fees and costs. The contractor is responsible for all fees and costs including any changes, or additions in scope to the Electrical Safety Authority inspection fees.
 - The work shall be in accordance with the drawings and specifications, and shall meet Ontario Electrical Safety Code (OESC), latest Edition and its bulletins, the latest regulations of Ontario Building Code (OBC), and applicable Municipal, Provincial and Federal Codes and Regulations. The Code, Regulation, statute, By-law or this specification having the most stringent requirement applies.
 - Submit manufacturers' warranty certificates for all the supplied electrical equipment to the Engineer. Warranty certificates shall not be less than twelve (12) months period. Refer to Contract General Conditions.

1.15. Submittals

- Submit electronic copies in PDF format of all shop drawings, data sheets and manufacturer's literature for all work and material supplied by the contractor with the exception of conduit, standard conduit fittings and low voltage wiring.
- Submittals must include details requested in the Specifications. The data must show manufacturer's name and all details of construction, dimensions, capacities, weights, and electrical performance characteristics of equipment or material.
- All shop drawings and data sheets must be submitted for review prior to procurement, fabrication or site work.

1.16. Record Drawings

- Refer to Division 1 for preparing record drawings. As job progresses, mark these prints to accurately indicate installed works. Have these prints available for inspection at the site at all times and present for scrutiny at each job meeting.
- Upon completion of construction, provide to the Engineer a complete set of final record drawings (full size) which shall include the following information:
 - Schematic logic and wiring diagrams of all components, controls and relays.
 - Revisions due to change orders, site alterations or additions, and field order changes made during construction.

- Interconnecting wiring diagrams showing all field connections to devices and equipment supplied by other Divisions.
- Include the record drawings, a list of motors, indicating motor, or equipment number and name, nameplate, voltage, horsepower, and current, size of overload, breaker and fuse protection rating provided for each motor.

1.17. Operation and Maintenance Instruction Manuals

Provide all operation and maintenance instruction manual documentation per Section 01100 General Instructions for inclusion in the project manuals.

1.18. Clean-up

- On completion of the work under this Contract, all protection erected under this section shall be removed.
- Any damage to this work, the facility and site resulting from the execution of the work of this section shall be repaired to original condition.
- All surplus materials, debris, tools, etc. shall be removed from the premises, and the facility and site left in a condition satisfactory to the Owner.

1.19. Warranty

- The product manufacturer shall issue a written and signed document in the name of the Owner, certifying the product will meet all of the physical characteristics published by the manufacturer, for the manufacturer's standard warranty period from the date of Substantial Completion.
- The contractor shall issue a written and signed document in the name of the Owner certifying that the work executed shall remain in place and free of any performance defect, for a period of one year from the date of Substantial Performance.
- Provide manufacturers' standard warranty if greater than one year.

2.0 Products

2.1. Materials and Equipment

- All equipment, materials, wiring and devices supplied under this Division to be CSA or ULC approved for use as installed and affixed with CSA or ULC labels. Where there is no alternative, in the Engineer's opinion, to supplying equipment and material which is not CSA or ULC certified, obtain and pay for all special approvals from the CSA Special Inspection Department and Local Authorities.
- All equipment, materials, wiring, and devices supplied under this Division to be designed and manufactured in accordance with applicable

EEMAC/NEMA specifications, unless otherwise specified. No IEC Standards or equipment shall be accepted.

- All service panels, control panels, control stations and component assemblies to be factory assembled and tested.
- All equipment supplied under this Division shall be installed as per the requirements of this specification, Ontario Electrical Safety Code (the "Code") and its bulletins, as per the requirements of the latest edition and amendments of all applicable codes and standards including the following:
 - CSA Canadian Standards Association
 - OBC Ontario Building Code
 - ANSI American National Standards Institute
 - IEEE Institute of Electrical and Electronics Engineers
 - NFPA National Fire Protection Association
 - EEMAC Electrical Equipment Manufacturers Association of Canada
 - NEMA National Electrical Manufacturers Association

2.2. Finishes

- Unless otherwise indicated, shop finish surfaces of all the electrical equipment by application of one coat of rust resistant primer inside and outside, and a minimum of two coats of high quality ASA-61 paint.
- Where site finishing is scheduled or required for shop-painted equipment that is scratched or marred during shipment and/or installation, prepare, prime to match original finish to the Engineer's satisfaction. Obtain necessary touch up paint of original type and quality from equipment manufacturer.
- Clean and prime exposed non-galvanized hangers, racks, and fastenings to prevent rusting. Feather out edges of scratch marks. Make patches inconspicuous.
- Do not paint nameplates, tags, warning plates and operating instructions. Observe field painting of electrical equipment or raceways.

2.3. Equipment Identification

- All labels provided by the Local Authorities and manufacturers' nameplates showing the size, name of equipment, serial number, voltage, cycle, phase, horsepower, etc. to be permanently affixed by non removable devices such as rivets to the appropriate equipment, and be visible and legible after completion of the installation and field painting. Chemical adhesives shall not be used to hold nameplates.
- All electrical, instrumentation and control equipment, including all central and remote process and mechanical equipment controls to be individually provided with permanently affixed appropriate engraved equipment nameplate identifications by means of non-removable devices such as rivets. Chemical adhesives shall not be used to hold nameplates.

2.4. Nameplates

- Lamacoid 3 mm thick, white face, black core, mechanically attached to equipment with non-corroding self-tapping screws or rivets. Grind protruding screws flush with inside surface to prevent injury.
- Lamacoid red face, white core for devices, drives, panels, transformers, and outlets that are powered from uninterruptible or emergency power supplies.
- Labels: Embossed plastic labels with 6 mm high letters unless otherwise specified.
- Submit schedule of nameplate sizes and wordings for all the supplied equipment to the Engineer for review prior to manufacture.
- Allow for average of twenty-five (25) letters per nameplate and label unless advised otherwise by the Engineer.
- All identification to be in English language.
- Nameplates for terminal cabinets, junction boxes and pull boxes to indicate system and voltage characteristics.
- Disconnects, starters and contactors: indicate equipment being controlled and voltage. Nameplates to be mounted externally on switch box covers.

2.4.1. Lighting Panels

- Plates to be mounted on outside of door, typical identification - "Lighting Panel LP, 120/208 V, 3 Phase, 4 Wire".

2.4.2. Power Distribution Panels

- Plates to be mounted on outside of door, typical identification - "Power Distribution Panel PDP, 600/347 V, 3 Phase, 3 Wire".
- On the face of control panels, service panels or enclosures which contain power fed from more than one live source, provide a 40 x 100 mm warning nameplate inscribed as follows. "CAUTION CONTAINS MORE THAN ONE LIVE SOURCE"
- Nameplate lettering sizes unless otherwise advised by the Engineer:
- Control Panels: Main nameplate: minimum 70 mm high and 300 mm long, with 25 mm engraved lettering. Individual components, control device, indicator nameplates: 10 mm engraved lettering.
- Local Panels, Service Panels and Operator Stations: Main nameplates: 13 mm engraved letter size. Individual devices: 10 mm engraved letter size.
- 120/208V Panelboards: 13 mm engraved letter size.
- Pushbutton Stations: 10 mm engraved letter size.
- Terminal Boxes: 10 mm engraved letter size.
- Junction Boxes: 10 mm engraved letter size.
- Motors: 10 mm engraved letter size.
- Disconnect Switches: 13 mm engraved letter size.

- Field Instruments and Devices: 10 mm engraved letter size.
- Panels and any other equipment which have exposed faces in finished areas shall not have any visible trademarks or other identifying symbols and nameplates shall be mounted behind doors.
- Warning signs: Lamacoid, white letters on red background.

2.5. Wiring, Conduit and Cable Identification

- All wiring to be identified with permanent identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of all feeders and all branch circuit wiring.
- Maintain same phase sequence and colour coding throughout the complete project.
- Colour code to be in accordance with CSA C22.1 - latest edition.
- Use colour coded wiring in fire alarm system cables, matched throughout the system.
- Colour code conduits, boxes, and metallic sheathed cables.
- Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals
- Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

2.6. Wiring of Systems and Equipment Supplied by Others

- Unless otherwise specifically stated in the Contract Documents, the Contractor under this Division shall be responsible for the supply and installation of all control, instrumentation, communication and special wiring, including all material and labour required to install systems and equipment being supplied under a different Division.
- The Contractor shall be responsible to review of all Contract Drawings, preselection documents and specifications, so as to identify wiring that falls into this category. The Contractor shall coordinate with other Divisions, so as to assure all wiring costs are carried as part of this Division.
- Where stated in these documents (Specifications and Contract Drawings) that others are to provide wiring, it will still be the responsibility of this Division to provide all material and labour required to properly install this wiring.
- Follow all manufacturers written installation instructions and details. Review installation requirements prior to installation of any conduit, raceway, ducts, cable tray support structure or electrical device and assure compliance with the manufacturer's requirements for proper installation of the equipment. Co-ordinate with other Divisions prior to commencing any work.

2.7. Ambient Environment

- Unless otherwise indicated, supply equipment enclosures, boxes, electrical materials and products suitable for ambient environment of areas in which

they are located. The anticipated maximum ambient temperature indoors is 40°C. Accordingly, all indoor electrical equipment shall be rated for 50°C as a minimum.

3.0 Execution

3.1. On Site Usage and Instructions

- The Owner has the privilege, at no extra cost, of the trial usage of the systems in this Division, or parts thereof, for the purpose of testing and learning the operational procedures. Trial usage shall not be construed as acceptance by the Owner.
- Carry out trial usage over a length of time as deemed reasonable by the Engineer at no extra cost.
- Carry out the operations with the express knowledge and under supervision of the Contractor who shall not waive any responsibility because of trial usage.
- Prior to the project takeover by the Owner, provide Owner's operating/maintenance personnel with on-site training in the testing, operations, and maintenance of all the systems and equipment. Arrange for training to be carried out by qualified personnel.
- Arrange and pay for services of manufacturers' factory service engineers to supervise start-up of installation, check, adjust, balance, and calibrate components.

3.2. Preparation and Protection

- Supply and install, as directed by the Engineer, all specified warning signs to meet the requirements of all the local authorities and Engineer. Warning sign nameplates to be engraved lamacoid, white lettering on red background, fastened with stainless steel screws.
- Schedule and expedite the works under this Division in co-operation with other trades in the building so as not to interfere with other works. In areas where the ducts, conduits, wiring and equipment for other Divisions will be installed in proximity to conduit, wiring, and equipment pertaining to this Division, install all conduits, ducts, wiring, and fittings to be embedded or plastered over, neatly and close to the building structure to minimize furring.
- Maintain at job site, at all times, qualified personnel and supporting staff, with proven experience in installing, supervising, and testing projects of comparable nature and complexity.
- Include all costs for overtime (premium time) work which may be required in the opinion of the Owner to change over, reconnect existing services (power, signals, branch circuit, wiring, etc.) that cannot be done during regular working hours. No additional charges shall be accepted by the Owner for work that has to be done on premium time to maintain the necessary continuity of services within the building.

- Responsible for any additional handling or transportation of the equipment that is necessary and for storage of the equipment on site to give protection against weather, damage, and theft, as per manufacturer's recommendations.
- Install conduit and sleeves prior to pouring of concrete. Size sleeves through concrete for free passage of conduit or cable.
- Roof and exterior wall openings shall be flashed and weatherproofed.
- Provide protection to personnel working on exposed electrically energized equipment on the project from any physical danger. Shield and mark live part "LIVE – 120 or 600 VOLTS" or with the appropriate voltages.
- Install equipment, conduit and cables in a professional manner to present a neat appearance and to function properly to the satisfaction of the Engineer. Install exposed conduit runs parallel and perpendicular to building planes. Install conduit concealed in chases, behind furring, or above ceiling, except in unfinished areas. Install exposed systems neatly and group to present a neat appearance.
- Include in the work requirements of manufacturers shown on the shop drawings.
- Replace any work unsatisfactory to the Engineer without extra cost, if the work is not done according to the drawings and specifications in the opinion of the Engineer.
- Bear costs for cutting and patching resulting from failure to coordinate timely installation of electrical inserts, sleeves and similar items into structures. Obtain the approval of the Engineer before doing any cutting or patching. Supporting members of any floor, wall or the building structure shall be cut only and in such a manner as approved by the Engineer. Arrange to have all patching done by the respective trades whose work is affected. This work shall be performed in accordance with the requirements of the applicable Division of the Contract Documents.
- Lugs, terminals, and screws used for termination of wiring to be designed for copper conductors.
- Where required the following sleeving materials shall be used:
 - Through all interior walls use Schedule 80 PVC pipes, flush with finished structure.
 - Through all exterior walls above grade use Schedule 80 PVC pipes, flush with finished structure inside and to suit flashing on outside.
 - Through all exterior walls below grade and all other waterproof walls use Schedule 80 PVC pipes.
 - Through all waterproof floors, through janitor's closets and through roofs use Schedule 80 PVC pipes. Extend sleeves 100 mm above finished floor upwards and cut flush with underside of floor.
 - Remove all debris, surplus material, and all tools upon completion of construction.

3.3. Outlet Locations and Conduit Runs

- The Engineer reserves the right to change any outlet location and conduit run at no extra cost or credit, providing the distance is within 3000 mm of the said location shown on the drawings and the information is given to the Contractor prior to installation.
- Where switches and receptacles are in the same location, outlets to be lined up vertically unless otherwise specified.
- Do not install outlets back-to-back in wall. Allow minimum 150 mm horizontal clearance between boxes.
- Locate light switches on latch side of doors. Locate disconnect devices in mechanical rooms on latch side of doors. Check door swing prior to installation.

3.4. Mounting Heights

- Mounting height of equipment shall be from finished floor to centerline of equipment unless specified or otherwise indicated.
- If mounting height of equipment is not specified or indicated, verify with Engineer before proceeding with installation.
- Electrical equipment to be installed at following specified heights, unless indicated otherwise:
 - Local Switches: 1400 mm.
 - General Wall Receptacles: 300 mm.
 - Receptacles over counters or counter splash backs: 175 mm.
 - Mechanical and process areas: 1400 mm.
 - Above top of continuous baseboard heater: 200 mm.
 - Panelboards: as required by Code or as indicated.
 - Telephone and inter-phone outlets: 300 mm.
 - Wall mounted telephones and inter-phone: 1500 mm.
 - Wall mounted speakers: 2500 ~ 3200mm.
 - Fire alarm pull stations: 1400 mm.
 - Fire alarm audible alarm horn: 2500 ~ 3200mm.
 - Data outlets: 300 mm.
 - Disconnect switches: 1400 mm.
 - Local Service Panel and Control Stations: 1400 mm.
 - Wall mounted local control panels: 1400 mm.
- Height of operating handles, switches and controls, 1400 mm maximum, including allowance for housekeeping pads.

3.5. Penetration Seals

- Unless advised otherwise, where sleeves or openings are installed in walls, below grade exterior walls, floors, roofs, or partitions to accommodate raceways, cables, cable bus, provide necessary watertight barrier seals, fittings, barriers, and fire resistant materials to permanently restore the

installation to its original fire rating. Supervise work affecting the electrical installation.

- Provide permanent watertight barrier seals for below grade exterior wall/floor electrical penetrations. For single conduit, duct or cable penetrations, use FSK type fittings as manufactured by O-Z/Gedney Co.
- Provide engineered compression type, cast-in transit system, sized to accommodate all conduits and ducts, cables, for multiple conduits, ducts or cable penetrations in below grade exterior walls and floors. Allow for a minimum of 25% of cross-section for future addition of conduit or cables. Acceptable transit system manufacturers are Transit Barrier System by Appleton Electric and Multi-Cable Transit by Wieland Electric.

3.6. Hangers and Supports

- Provide all required plates, supports and hardware for electrical and instrumentation equipment.
- Provide non-corroding spacers (nylon washers) to be provided for equipment fastened to necessary walls to ensure a minimum spacing of 6 mm between the enclosure and wall.
- Provide expansion anchors, type HDI by Hilti (Canada) Ltd. machine screws or threaded rods and nuts for supporting hangers or straps.
- Provide 'KWIK-CON' anchors by Hilti (Canada) Ltd. for attaching switch boxes, outlets, conduits, conduit fittings, and similar items to concrete.
- Ground metallic supports. Do not use them as ground conductors for electrical equipment.
- All prefabricated steel supports, such as channels, struts, bracket, hangers, slotted angles, and similar items to be hot dip galvanized. Bolt or clamp these supports. Do not field weld these supports. Repaint cut sections with zinc rich galvanizing primer.
- Provide fire retardant treated plywood backboards.
- Do not use powder activated tools without the written permission of the Engineer.

3.7. Cleaning

- Prior to energizing any systems, inspect and clean the interior and exterior of all the equipment, including switchgears, switchboards, motor control centres, transformers, power panel boards, lighting panel board, enclosures, service panels, control panels, etc. to the satisfaction of the Engineer.
- Clean all lighting reflectors, lens, and other lighting surfaces that have been exposed to construction dust and dirt. Replace all the burned out lamps.
- Remove all construction debris, surplus materials, and tools on daily basis.
- Carry out additional cleaning operations of systems as specified in other sections of this Division.

3.8. On-Site Tests

- Conduct and pay for all the tests required to check for the operation of all the electrical systems for compliance with the contract documents, statutory and regulatory authority requirements. All defects shall be corrected and adjustments to be made at no extra cost prior to requesting inspection by the Engineer.
- Provide the Engineer for review prior to energization with each equipment manufacturer's certificate or letter confirming that the complete installation as it pertains to each system has been installed to the manufacturer's instructions.
- In co-operation with mechanical trades, perform clamp-on ammeter readings for all the phases of all the mechanical equipment with motors operating at full load condition. Log, tabulate, and incorporate these readings into Operations and Maintenance Manuals.
- Carry out the following additional tests:
 - Insulation resistance testing:
 - Megger all lighting circuits, feeders, and equipment up to 350 V with a 500 V instrument and record insulation resistance value between live parts and ground.

3.9. Demonstration and Training

Instruct Owner's personnel in the operation, care and maintenance of equipment.

End of Section

Table of Contents

1.0 General..... 1

 1.1. Intent of Section..... 1

 1.2. Codes and Standards..... 1

 1.3. Shop Drawings 1

 1.4. Operations and Maintenance Manuals 2

2.0 Products 2

 2.1. General Requirements 2

 2.2. Power Cables for 208 V Circuits (Copper Conductor) 2

 2.3. Building Wires..... 3

 2.4. Control Cables..... 3

 2.5. Fire Alarm System Cables 4

 2.6. Wiring Accessories 4

 2.7. On-Site Tests..... 4

 2.8. Acceptable Manufacturers 4

3.0 Execution..... 5

 3.1. Coordination 5

 3.2. Installation 5

 3.3. Wiring Terminations..... 6

 3.4. Inspection and Test Procedures 7

 3.4.1. Visual and Mechanical Inspection..... 7

 3.4.2. Electrical Test - Cable and Wire (1000V and Below) 7

 3.4.3. Electrical Test - Instrumentation and Thermocouple Extension Wiring..... 7

 3.5. Test Values 7

1.0 General

1.1. Intent of Section

- The works to be done under this section shall include the design and supply of materials and equipment required for installation, furnishing of labour, testing, and putting into proper operation complete electrical systems as specified and as otherwise required.
- The Contractor shall comply with the requirements listed in Division 1 - General Requirements and in Section 16010 - Electrical General Requirements.
- Provide all required wiring and conduits for the following systems:
 - New Building Automation System.
 - Replacement of Mechanical equipment including roof top AC units
 - All cables and wires supplied under this section shall be provided by a single manufacturer unless specified otherwise.
- Drawings do not necessarily show all the required wiring for each individual equipment. Provide all the required wiring for the shown equipment and device regardless of whether or not the wiring is shown on the drawings and/or specified herein so as to provide fully functional systems to operate as specified herein.
- All wires and cables shall be handled and stored in accordance with the manufacturer's instructions.

1.2. Codes and Standards

- Provide equipment which meets the requirements of Ontario Electrical Safety Code (the "Code") and its Bulletins, Latest Edition, the latest edition and amendments of the following codes and standards:
 - CSA C21.1 600 V Control Cable.
 - CSA C21.2 300 V Control Cable.
 - CSA C22.2 No.0.3, Test Methods for Electrical Wires and Cables.
 - CSA C22.2 No. 38 Thermoset Insulated Wires and Cables.
 - CSA C22.2 No. 131 Type TECK 90 Cables.
 - CSA C22.2 No. 174 Cables and Cable Glands for use in Hazardous Locations.
 - CSA C68.3 Power Cables with Thermoset Insulation.
 - ICEAS-66-524.Cross-Linked-Thermosetting-Polyethylene Insulated Wire and Cable.
- All wires and cables shall bear CSA approval sticker.

1.3. Shop Drawings

- Conform to Division 1 except as varied by this Section.

- Before starting any work, submit shop drawings and product data in accordance with Division 1 as follows:
 - Complete assembly description and layouts of the complete plant showing all proposed conductor and conduit sizes.
 - List of recommended terminating material.
 - Recommended method of terminating the cables.

1.4. Operations and Maintenance Manuals

- Conform to Division 1 except as varied by this Section.
- Submit the following information:
 - All information listed in Item 1.3.
 - Installation instructions.

2.0 Products

2.1. General Requirements

- Comply with standards listed in Item 1.2.
- All wire and cables shall be copper conductor

2.2. Power Cables for 208 V Circuits (Copper Conductor)

- Each cable shall be CSA type RW90-XLPE cable as per CSA C22.2 No. 38, copper conductor, resistant to moisture and oil with an overall FT4 rating. 600 V minimum rating for conductors, cables shall be provided with 100% insulation.
- RW90XLPE - Chemically cross-linked thermosetting polyethylene for indoor and above ground installations.
- RWU90XLPE - Chemically cross-linked thermosetting polyethylene for outdoor or underground installations.
- Each cable shall be designed to operate continuously at 90°C conductor temperature, at 130°C emergency, and at 250°C short circuit. The cable, its accessories, and components shall be installed exclusively in conduits. Cable shall be suitable for operation in ambient air temperature of 50°C with relative humidity of 95%.
- Conductor shall be soft drawn bare copper, ASTM Class B, concentric lay stranding up to size 8 AWG. Size 6 AWG to 1000 kcmil to be compressed stranding.
- Conductor insulation shall be thermosetting cross-linked polyethylene insulation with an average thickness as specified in the above-mentioned standards.
- The cable shall be suitable for a minimum installing temperature of -40°C and shall meet or exceed the requirements of ICEA standards.

- Phase conductors shall be identified by colour markers. The three colour markers shall be black, red and blue.
- Grounding conductors shall be the same material and stranding as the phase conductors. Each conductor to be sized in accordance with CSA C22.2 No. 38 standard.

2.3. Building Wires

- For 240 V and 120 V circuits, provide copper conductor cable RW90 with 90°C thermosetting cross-linked polyethylene insulation 600 V. Minimum installation temperature minus 40°C.
- Each cable, its accessories, and components shall be installed indoors exclusively in conduits. Cable shall be suitable for operation in ambient air temperature of 50°C with relative humidity of 95%.
- Building wires shall be size #12 minimum and larger.

2.4. Control Cables

- Size and install all wire and cable in accordance with CSA, Ontario Electrical Safety Code, IEEE and other applicable electrical safety codes.
- Terminate all internal panel wiring to external devices at the terminal strips. Connect all field wiring to one side of the terminal strip. Connect all panel wiring to the opposite side. Arrange terminals for external connects in consecutive order for conductors within a given cable. Not all terminals are shown in the control schematics on the contract drawings, it is the contractor's responsibility to provide all terminals as required.
- Provide stranded annealed copper conductors with PVC insulation type. Metallic tape shielding shall be provided over each pair and over all conductors including overall covering of PVC jackets. Control cables shall be 14 AWG. minimum, RW90 XLPE insulated, 600 V rated conductors.
- Where conductors to be buried, RWU90, XLPE, 600 V rated conductors to be provided. Run wires in continuous lengths from terminal to terminal. Do not splice wires.
- Segregate signal wiring from control power wiring: group functionally, and arrange neatly to facilitate tracing of circuits. Arrange wiring, respective terminals and 20% spare in separate mounting rails according to the following categories: 120 V AC, 24 V DC signal, 24 V DC control, communication wiring.
- Use plastic wiring wraps to bundle wires, outside of wiring ducts. Securely fasten the bundles to the steel structure at intervals not exceeding 300 mm. Each bundle contains 30 conductors maximum. Use Panduit, or equal wiring ducts and size to provide a minimum of 20 percent spare space not less than 5 per terminal block.
- Do not intermix signals within the same bundle or duct.
- Use twisted unshielded wire for other DC signals and segregate from wire conducting AC signals.

- Unless otherwise shown on the Contract Drawings provide minimum 20% spare wiring or 2 conductors (1 pair) whichever is greater.

2.5. Fire Alarm System Cables

- As specified on the Contract Drawings.

2.6. Wiring Accessories

- Wire markers: Plastic slip-on, black letters on white background. Shur-Code by Thomas & Betts Ltd., Z-Type by Wieland Electric Inc.
- Cable markers: For cables or conductors greater than 13 mm diameter, strap-on type, semi rigid PVC carrier strip. Type K by Wieland Electric Inc.
- Terminal blocks: 600 V, 25 A minimum rating, modular, 35 mm DIN rail mounted, provision for circuit number labelling, individually removable sized to accommodate conductor size and circuit current. Sak Series by Weidmuller Ltd., UK Series by Phoenix Terminal Blocks Ltd., WK Series by Wieland Electric Inc., Entrelec.
- Field wiring terminations: Where screw-type terminal blocks are provided, supply insulated fork tongue terminals. Sta-Kon by Thomas & Betts Ltd., Scotchlok by 3M Canada Inc.
- Splice connectors for equipment pig-tail, lighting and receptacle circuits: For wire sizes #12 and #10 AWG inclusive, twist-on compression spring type. Wing-Nut by Ideal., Marrette Type II by Man Electric Ltd.
- Moisture and waterproofing: In wet locations, with Liquid Tape by Ideal
- Equipment pig-tail power circuit connections: For wire sizes #8 AWG minimum, split-bolt type, sized to suit number and size of conductors. Servit Type KS by Burndy Inc.
- Cable ties: Nylon, one-piece, self-locking type, by Thomas & Betts Ltd., Burndy Inc., Wieland Electric Inc.
- Cable pulling lubricant: Compatible with cable covering and not to cause damage or corrosion to conduits or ducts. Yellow 77 by Ideal.

2.7. On-Site Tests

- Perform all tests (including hi-pot test, meggar tests, etc.) with necessary instruments to demonstrate that cables are free from short circuits or grounds. Minimum acceptable value for insulation resistance test is 200 megohm.

2.8. Acceptable Manufacturers

- General Cable Ltd.
- BICC Phillips Inc.
- Pirelli
- Alcan
- United Wire and Cable

- Nexans

3.0 Execution

3.1. Coordination

- Prior to installation of wiring, compare Contract Drawings with latest issue of Vendor shop drawings.
- Report discrepancies promptly to Consultant.

3.2. Installation

- Install cables and cable systems, as per manufacturers' recommendations and as shown on the Contract Drawings.
- Provide appropriate type connectors and terminations as recommended by the cable suppliers.
- Grounding conductors running together with phase conductors to be same size and insulation of phase cables. Colour to be green.
- In-line splices are not acceptable.
- Do not make splice in any of the instrumentation cable runs.
- Pull cable into ducts, conduits and cable trays in accordance with cable manufacturer's recommendations. Use patented cable grips suitable for cable type, or pulling eyes fastened directly onto cable conductors.
- Prevent damage to cable jackets by utilizing adequate lubricant when pulling cables through ducts and conduits.
- Limit pulling tension and minimum bending radii to those recommended by manufacturer.
- Cable pulling, cable installation or handling shall be carefully done to avoid any damage in the external jacket/insulation. Any damage will result in rejection to entire length of cable.
- Arrange cables in parallel rows on cable trays. Maintain cable spacing by fastening cables, with "P" clips, every 2000 mm minimum on straight horizontal runs and to each rung at bends, including two rungs of adjoining straight sections. Fasten cables on vertical tray runs every 1000 mm maximum.
- Connect cables to electrical boxes and equipment enclosures located in wet or sprinkled areas with watertight cable connectors.
- Provide cable grips for vertical and catenary cable suspension installations to reduce cable tension at connectors and at cable bends.
- Install through wiring in junction and pull boxes having no connection within the box. Leave 150 mm minimum of slack inside box.
- Facilitate making of joints and connections by leaving sufficient slack in each conductor at panelboards, outlet boxes and other devices.
- Do not connect more than three lighting circuits for three phase panels and two lighting circuits for single phase panels to a common neutral.
- Use #10 AWG minimum for home runs to lighting panels exceeding 25 m.

- Install instrumentation signal and thermocouple extension wires in separate raceways from power and control wiring.
- Provide mechanical protection for cables within 1500 mm of the floor in buildings and within 2000 mm above grade outdoors.
- Identify each cable by attaching a cable marker at each end, in all intermediate access holes, junction boxes and pull boxes.
- Provide cable grips on vertical and horizontal catenary cable suspensions.
- All bare grounding conductors shall be properly terminated.
- Control cable shields shall be grounded.
- Where cables are not run in tray, support on Unistrut channels with a maximum spacing of 1 metre between intervals. Run cables parallel to the lines of the building. Bends to be concentric. Group cables wherever possible.
- Fasteners for all cables on Unistrut channels shall be cable clamp type. Use non-ferrous fasteners in wet locations.
- Cinch anchors shall be used to fasten the Unistrut brackets to walls. Concrete beams shall not be drilled without prior authorization by the Consultant. Care shall be taken in drilling concrete blocks or masonry work to ensure the surface will not be cracked.
- Where vertical runs are required and walls, columns or equipment supports are not adjacent, Unistrut channels complete with beam clamps and floor anchor plates shall be provided. Unistrut sections for this purpose shall be sized as required.

3.3. Wiring Terminations

- Insulate equipment pig-tail power circuit connections with wire sizes #8 AWG and larger, with heat shrink sleeving termination kits.
- Terminate armoured cables with accepted connectors suitable for application, size and type of cable.
- Make power (1000 V and below), control and instrumentation wiring taps and terminations in junction boxes with labeled terminal blocks, securely fastened to avoid loosening under vibration or normal strain. Terminate lighting circuits and 120 V convenience receptacle circuits with twist on or split-bolt type connectors and insulating tape.
- Terminate control, signal and instrumentation circuit conductors, including spares, on terminal blocks. Label terminal blocks with unique alphanumeric designation.
- Identify each conductor, including spares, by wire markers at each termination. Indicate circuit designation or unique wire number. Identify spare conductors as 'SP1', 'SP2', etc.

3.4. Inspection and Test Procedures

3.4.1. Visual and Mechanical Inspection

- Compare cable data with Contract Drawings and specifications.
- Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram. Report any scratches or any kind of stress in the insulation/jacket.
- Verify tightness of accessible bolted connections by calibrated torque wrench in accordance with manufacturer's published data.
- Inspect compression-applied connectors for correct cable match and indentation.
- Verify cable colour coding with applicable Consultant's specifications and CSA standards.

3.4.2. Electrical Test - Cable and Wire (1000V and Below)

- Conduct insulation resistance measurements using a "Megger" (500V instrument for circuit up to 350V systems, 1000V instrument for 351-600V systems).
- Replace or repair circuits which do not meet Inspection Authority requirements. With equipment disconnected, measure insulation resistance of the following circuits:
 - Power, lighting, heater and motor feeders: Phase-to-phase, phase-to-ground.
 - Control circuits: To ground only.
- Do not perform "Megger" tests on equipment containing solid-state components.
- Disconnect power factor correction capacitors from system prior to testing.

3.4.3. Electrical Test - Instrumentation and Thermocouple Extension Wiring

- Check continuity of each conductor using ohmmeter or DC buzzer. Megger or 120 V filament lamp testing is not acceptable.
- Test thermocouple wiring for continuity and polarity in accordance with manufacturer's recommendations.

3.5. Test Values

- Bolt-torque levels shall be in accordance with the manufacturer's specifications.
- Minimum insulation-resistance values shall be not less than 200 megohms utilizing a 1000 V megohmmeter for one minute.
- Investigate all deviations between adjacent phases.

End of Section

Table of Contents

1.0 General..... 1
 1.1. Intent of Section..... 1
 1.2. Codes and Standards..... 1
 1.3. Shop Drawings 1
 1.4. Operations and Maintenance Manuals 1
2.0 Products 1
 2.1. General..... 1
 2.2. Conduit Boxes 2
 2.3. Sheet Steel Outlet Boxes 2
 2.4. Pull and Junction Boxes 2
 2.5. PVC Boxes 3
 2.6. Fittings - General..... 3
 2.7. Acceptable Products..... 3
3.0 Execution..... 3
 3.1. General..... 3

1.0 General

1.1 Intent of Section

- The works to be done under this section shall include the design and supply of materials and equipment required for installation, furnishing of labour, testing, and putting into proper operation complete electrical systems as specified and as otherwise required.
- This section covers the requirements for the supply and installation for all electrical boxes and fittings.
- Comply with the requirements listed in Division 1 - General Requirements and Section 16010 - Electrical General Requirements.
- Allowances shall be made in locating boxes to avoid overhead pipes, ducts, and other obstructions.
- All equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) set of instructions shall be included in the shipment of the equipment.

1.2 Codes and Standards

- Provide equipment which meets the requirements of this specification, Ontario Electrical Safety Code (the "Code") and its Bulletins, the latest Edition and amendments of the following codes and standards:
 - Ontario Building Code
 - CSA
 - EEMAC
- All equipment shall bear a CSA or ULC approved sticker label with the inscribed certificate number.

1.3 Shop Drawings

- Submit shop drawings and product data in accordance with the requirements listed in Division 1.
- Mark locations and sizes of outlets, junction and pull boxes on drawings.

1.4 Operations and Maintenance Manuals

- Submit the following information:
 - All information listed in Item 1.3.
 - Installation instructions.

2.0 Products

2.1 General

- Reference: CAN CSA C22.2 No. 18-M1987
- Size boxes in accordance with CSA C22.1.

- Enclosure Rating
 - Where required, concealed or recessed outlet, junction and pull boxes shall be EEMAC 1 unless otherwise indicated, standard galvanized stamped steel, minimum 50 mm deep with covers and integral vapour barriers where required by local codes.
 - Electrical Room: NEMA/EEMAC 12, unless otherwise noted on the drawings.
- Gang boxes shall be used at all locations where more than one device is to be mounted.
- All boxes without any wiring devices shall be provided with blank cover plates.
- Special devices shall be provided with 4" square or larger outlet boxes.
- Provide a grounding stud in each outlet, junction and pull box.
- Where required, surface mounted outlet boxes, pull and junction boxes of 150 mm x 150 mm size or smaller shall be cast, construction, corrosion resistant, ferrous alloy boxes, complete with threaded conduit hubs and gasketed covers as manufactured by Appleton or equal.
- Combination outlet boxes with covers and integral vapour barriers shall be provided in locations where outlets of more than single system are installed. Boxes shall be cast ferrous alloy or copper free aluminum, corrosion resistant, complete with single gang covers.
- Provide pull boxes for conduits larger than 31.75 mm (1.25 inches) and conduit outlet boxes for conduits smaller than 31.75 mm (1.25 inches).
- All outlet boxes shall be filled with suitable filler material to prevent entry of foreign materials.
- Double lock nuts and insulated bushings shall be provided on sheet metal boxes.
- Each box shall be provided with a ground stud.

2.2. Conduit Boxes

- Provide cast FS boxes complete with mounting feet and factory threaded hubs for wiring of switches, receptacles and telephone outlets.

2.3. Sheet Steel Outlet Boxes

- Lighting fixtures shall be provided with 100 mm octagonal or square outlet boxes.
- Devices flush mounted in finished walls shall be provided with 100 mm square outlet boxes with extensions and plaster rings.
- Unless otherwise specified, provide single and multi gang flush mounted devices with outlet boxes with minimum size of 75 mm x 50 mm x 38 mm.

2.4. Pull and Junction Boxes

- Reference: CAN CSA C22.2 No. 40-M1989.

- Welded galvanize steel construction with screw-on flat covers for surface mounting and captive non-corroding chain.
- Covers with neoprene gasket and 25 mm minimum extension all around, for flush mounted pull and junction boxes.
- Supply piano type hinges on boxes larger than 300 x 300 mm min. Supply smaller box with screw mounted cover and captive non-corroding chain.

2.5. PVC Boxes

- Provide PVC outlet, junction and pull boxes conforming to CSA standards.

2.6. Fittings - General

- Bushing and connectors with nylon insulated throats.
- Knock out fillers to prevent entry of debris.
- Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.
- Double locknuts and insulated bushings on sheet metal boxes.

2.7. Acceptable Products

- Hammond Manufacturing Co.
- Robroy Industries
- Killark
- Appleton
- Crouse Hinds

3.0 Execution

3.1. General

- Each box shall be sized to accommodate the number of conduits, conductors and terminal blocks. Each box sized to accommodate 20% spare terminal block and associated wiring. No reducing washers are acceptable.
- Boxes shall be installed to avoid interference with all piping ducts and conduits.
- Recessed outlet box cut-outs shall be of minimum practical size.
- Surface mounted boxes shall be securely fastened to the building or mounting structures and supported independently of the conduits entering the boxes.
- All boxes shall be located in easily accessible areas and properly installed with suitable cable supports. Inaccessible areas shall be provided with access panels.
- For flush installations, mount outlets flush with finished wall using plaster rings and covers to permit wall finish to come within 6 mm of opening.

- Install junction and pull boxes mounted on brick, concrete or block walls with 3 mm thick lead or nylon washers between box and wall face.
- Pull and junction boxes to be sized as per the requirements of the Ontario Electrical Safety Code for all conduit raceway system lengths limited to 60 m. Raceway length shall be reduced by 10 m for every 90° bend or 8 m for every 45° bend or offset.
- Box sizes and locations shall be marked on record drawings.
- Replace, at no extra costs, all equipment that is found to be defective and/or incorrectly installed in the opinion of the Engineer during site inspections and testing.

End of Section

Table of Contents

1.0 General..... 1
 1.1. Intent of Section..... 1
 1.2. Codes and Standards..... 1
 1.3. Shop Drawings 1
2.0 Products 1
 2.1. Conduit Type 1
 2.2. Conduit Fastenings..... 2
 2.3. Conduit Fittings..... 2
3.0 Execution..... 3
 3.1. General..... 3

1.0 General

1.1 Intent of Section

- The works to be done under this section shall include the design and supply of materials and equipment required for installation, furnishing of labour, testing, and putting into proper operation complete electrical systems as specified and as otherwise required.
- Comply with the requirements listed in Division 1 - General Requirements and Section 16010 - Electrical General Requirements.
- Drawings do not show all the required conduits, fittings, and wiring. Conduit wiring shown on the drawings is for diagrammatic purpose only and does not detail exact or complete wiring or conduit requirements.
- It shall be the Contractor's responsibility to provide all required conduits, conduit fastenings and conduit fittings, regardless of whether or not it is shown on the drawings and/or specified herein so as to provide a complete functional system that shall operate as specified herein.
- All equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of the instructions shall be included with the equipment at the time of shipment.

1.2 Codes and Standards

- Provide equipment listed in this section which meets or exceeds Ontario Electrical Safety Code (the "Code") and its Bulletins, the latest edition and amendments of the following Codes:
 - CSA
 - EEMAC
 - ANSI
- All equipment shall bear a CSA or ULC approval sticker with the inscribed certificate number.

1.3 Shop Drawings

- Submit shop drawings and product data in accordance with the requirements listed in Division 1.

2.0 Products

2.1 Conduit Type

- Rigid galvanized steel threaded conduit to CSA C22.2 No. 45, keep threads clean and sharp. Threaded fittings, connectors and termination made with rigid steel couplings, concrete tight where required. Manufactured by either Longtin Conduits or MBF Electrical Products.
- Electrical metallic tubing (EMT) is not acceptable anywhere on this project.
- Liquid-tight flexible aluminum or galvanized steel conduit, spiral wound interlocking armour construction with overall extruded PVC jacket as

manufactured by either Anaconda or Easter Wire and Cable. Comply with CSA C22.2 No.56-M1977.

- Rigid PVC conduit, complete with elbows and fittings, schedule 40 thickness, solvent weld connections, as manufactured by either IPEX Inc. or Carlon. Rigid PVC conduits shall be used in underground, embedded in concrete and corrosion areas. Comply with CSA C22.2 No.211.2-M1984.

2.2. Conduit Fastenings

- Malleable iron, hot dip galvanized straps for rigid metal and PVC conduits. Provide PVC coated fastenings to suit PVC coated conduit installations.
- Use single hole straps for conduits 53 mm and smaller, and two hole straps for conduits larger than 53 mm.
- Hot dip galvanized steel beam clamps designed to secure conduits to exposed steel work.
- Channel type supports for two or more conduits at 1.5 m oc.
- Hot dip galvanized steel channel type supports, U shape, size 41 x 41 mm, 2.5 mm thick.
- Six (6) mm diameter threaded galvanized steel rods to support suspended channels. Provide all necessary galvanized steel spring loaded bolts, nuts, washers and lock washers.

2.3. Conduit Fittings

- Rigid PVC conduit connectors shall be adapter type with threaded male portion and as manufactured either by IPEX Inc. or Carlon.
- Expansion couplings shall be provided with ground straps or clamps and as manufactured by Crouse Hinds.
- Conduit spacers shall be malleable iron, sized to suit the conduit size and as manufactured by Thomas and Betts.
- Conduit seals and fittings for hazardous areas shall be appropriately rated and as manufactured by either Crouse Hinds, Killak, or Appleton Electric.
- Liquid tight flexible conduit connectors shall be provided with threaded grounded cores, nylon compression rings and glands, male bushing with integral O-ring seal as manufactured by Thomas and Betts.
- Rigid steel conduit connectors shall be malleable iron or steel, hub type, with nylon insulated throat or bushings, recessed neoprene O-ring, pressure type terminals for grounding wire connections as required and as manufactured by Thomas and Betts.
- Swivel couplings shall be threaded type and as manufactured by Elliot Electrical Manufacturing. Running threaded type shall not be accepted.
- Provide aluminum fittings and connectors for aluminum conduits as manufactured by MBF Electrical Products.
- Pull cords (6 mm) shall be polypropylene or nylon material.
- Watertight connectors and couplings shall be provided for all conduit runs.
- Elbows shall be provided where 90° bends are required for 27 mm and larger conduits.

3.0 Execution

3.1. General

- Conduits shall be installed to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass. Conduits shall be installed not less than 150 mm from all steam and hot water pipes with minimum of 50 mm at crossover, and not less than 1 meter from any heaters. All conduits to have both ends threaded and carefully internally reamed to remove burrs and provide smooth transmission. Carefully verify all conduit junctions to avoid any scratch on the insulation of conductors. Any scratch on the conductor insulation will be not acceptable and requires installation of new conductors.
- All exposed conduits shall be installed parallel or perpendicular to the building grid lines, and with approved pull boxes at bends in locations where conduits change direction. Provide a pull or junction box after a maximum of 3 bends or exceed 60 m in each run.
- Expansion joints shall be provided for all straight conduit runs that exceed 60 m and at every building expansion joint. Fittings shall be installed on the dry side of the plastic water stops.
- Provide heavy duty flexible liquid tight metal conduits between the rigid conduit system and any motorized equipment subject to vibration, such as motors.
- Pass conduits through waterproof membranes in accordance with the recommendations of the membrane manufacturer such that the integrity of membranes is not undermined. Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.
- Concealed conduits shall be installed in straight lines following construction lines, with a large radius bends.
- Use rigid PVC conduits with a minimum trade size of 21 mm for conduits embedded in concrete and corrosive areas in unclassified areas as noted on the drawings. Provide rigid galvanized steel threaded conduits with a minimum trade size of 21 mm in all hazardous areas required by Ontario Electrical Safety Code.
- Do not install horizontal runs in masonry walls. Do not install conduits in terrazzo or concrete toppings. Do not cut into the walls after the installation of the walls.
- Conduits penetrating floors shall be located to permit direct connections to motors and equipment without any bends.
- Protect conduits from damage where they stub out of concrete. Terminate stub-ups 100 mm above finished floor and seal with threaded cap.
- Provide insulated ground wire in all conduits for power supplies in accordance with the Ontario Electrical Safety Code.
- Conduits and fittings to be concrete embedded or plastered over shall be installed neatly and close to the building structure to minimize the furring.

- Exposed conduits shall be installed securely with all necessary accessories, including suitable steel hangers or single-hole straps spaced at 1.5 m centres. Perforated straps, hay wires, etc. shall not be accepted. Group conduits together whenever possible.
- Lead anchors, toggle bolts, or expansion bolts shall be used to attach clamps, clips, etc. to masonry walls. The use of powder activated type studs shall not be permitted unless authorized by the Engineer.
- Install sleeves where conduits pass through slab or wall.
- Conduits not shown on the drawings, but are required to provide complete operational systems, shall be sized as per Tables 6 and 9 of the Ontario Electrical Safety Code.
- Provide flexible metal conduits from junction boxes to lighting fixtures in office areas.
- Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits. Watertight caps shall be provided at both ends.
- Conduits shall be dried out and cleaned prior to installation of wires.
- A nylon fish rope shall be installed in every empty or lightly filled conduit. Leave 1 meter slack at either end.
- For PVC coated conduits, cut threads so that the die removes the plastic jacket. Coat the exposed areas with rust resistant primer. Strap wrenches shall be utilized for tightening conduit. Plastic-Bond Touch Up compound shall be applied on exposed conduit surfaces.
- Bend conduit cold. Replace conduit if kinked or flattened more than one tenth of its original diameter. Mechanically bend steel conduit larger than 21 mm diameter.
- Provide for each flush mounted panel board, two 25 mm spare conduits up to ceiling space and where applicable, provide two 25 mm spare conduits down through floor into ceiling or basement space below. Terminate these conduits in 152 mm x 152 mm x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in a surface type box.
- Surface conduit installation work shall not commence until all affected masonry ceiling, wall, and floor finishes are completed.
- Conduits shall be sloped to provide drainage. Provide drainage holes or C conduits in exposed conduits and non-hardening compound filled boxes for concealed conduits.
- Replace, at no extra costs, all the equipment that is found to be defective in the opinion of the Engineer during inspections.
- Reinstall, at no extra costs, all the equipment that is found to be incorrectly installed in the opinion of the Engineer.
- All conduits shall be installed in a clean and neat manner.

End of Section