

The Project Manual is bound in three separate volumes as follows:

Volume 1:	Project Specifications, Division 00 to Division 19
Volume 2:	Project Specifications, Division 20 to Division 29
Volume 3:	Project Specifications, Division 30 to Division 49

VOLUME 1

PROCUREMENT AND CONTRACTING REQUIREMENTS GROUP

Division 00 Procurement and Contracting Requirements

Introductory Information

00 01 01	Project Title Page
00 01 05	List Of Consultants
00 01 07	Seals Page
00 01 10	Table of Contents
00 01 15	List Of Drawings
00 01 20	List Of Schedules

Procurement Requirements

00 30 00	Available Information
----------	-----------------------

Contracting Requirements

Not Used

SPECIFICATIONS GROUP

GENERAL REQUIREMENTS SUBGROUP

Division 01 General Requirements

01 10 00	General Instructions
01 21 00	Allowances
01 29 00	Payment Procedures
01 30 00	Administrative Requirements
01 33 00	Submittal Procedures
01 35 43	Environmental Procedures
01 40 00	Quality Requirements
01 42 00	References
01 45 00	Testing And Inspection Services
01 45 16	General Requirements For Sound Control
01 50 00	Temporary Facilities And Controls
01 55 26	Traffic Control And Procedures
01 56 00	Temporary Barriers And Enclosures
01 57 00	Temporary Erosion And Sediment Control
01 60 00	Product Requirements
01 70 00	Execution Requirements
01 71 00	Examination And Preparation
01 77 00	Closeout Procedures
01 83 16	Exterior Enclosure Performance And Testing
01 95 00	Post Construction Survey

FACILITY CONSTRUCTION SUBGROUP

Division 02

Not Used

Division 03 Concrete

03 35 00 Concrete Floor Finishing

Division 04 Masonry

04 05 00 Common Work Results For Masonry
04 05 13 Masonry Mortar And Grout
04 05 19 Masonry Anchorage And Reinforcing
04 05 23 Masonry Accessories
04 22 00 Concrete Unit Masonry
04 26 13 Masonry Veneer

Division 05 Metals

05 41 00 Structural Steel Stud Framing System
05 50 00 Metal Fabrications

Division 06 Wood, Plastics, and Composites

06 10 00 Rough Carpentry
06 16 00 Exterior Gypsum Sheathing
06 40 00 Architectural Woodwork
06 61 16 Solid Polymer Fabrications
06 90 00 General Installations

Division 07 Thermal and Moisture Protection

07 11 00 Dampproofing
07 11 10 Underslab Vapour Retarder
07 21 00 Building Insulation
07 27 14 Impermeable Air Barriers
07 42 33 Solid Phenolic Panels
07 42 43 Aluminum Composite Panel System
07 42 46 Insulated-Core Metal Wall Panels (Non-Fire-Rated)
07 52 00 Modified Bituminous Sheet Roofing
07 61 13 Standing Seam Metal Roof Panels
07 62 00 Sheet Metal Flashing And Trims
07 84 10 Firestopping And Smoke Seals
07 92 00 Joint Sealants

Division 08 Openings

08 11 13 Steel Doors And Frames
08 14 16 Flush Wood Core Doors
08 34 16 Bi-Fold Hangar Doors
08 36 13 Exterior Sectional Overhead Doors
08 44 00 Curtain Wall
08 71 00 Finish Hardware
08 80 00 Glass And Glazing
08 91 00 Louvres

Division 09 Finishes

09 21 16 Gypsum Board
09 30 13 Ceramic Tile
09 51 00 Acoustic Tile Ceilings
09 65 13 Rubber Tile Flooring
09 65 30 Resilient Base And Accessories
09 65 36 Static Dissipative Resilient Flooring
09 65 66 Athletic Flooring

09 66 23	Seamless Resin Flooring
09 68 13	Carpet Tile
09 77 13	Acoustic Wall Panels
09 91 00	Painting

Division 10 Specialties

10 21 15	Phenolic Toilet Compartments
10 26 00	Wall Protection
10 28 00	Accessories
10 71 13	Exterior Sun Control Devices
10 75 00	Flagpoles

Division 11

Not Used

Division 12 Furnishings

12 23 14	Manual Roller Window Shades
12 35 71	Stainless Steel Casework

Division 13 Special Construction

13 34 24	Pre-Engineered Buildings
13 48 50	Seismic Control Assemblies For Operational And Functional Components

Division 14 to Division 19

Not Used

VOLUME 2

FACILITY SERVICES SUBGROUP

Division 20 Common Mechanical Requirements

20 05 00	Common Work Results for Mechanical
20 05 01	Pre-Tendered Mechanical Equipment
20 05 10	Mechanical Work General Instructions
20 05 13	Common Motor Requirements for Mechanical Equipment
20 05 13.13	Variable Frequency Drives for Mechanical Equipment
20 05 17	Sleeves and Sleeve Seals for Mechanical Piping
20 05 19	Meters and Gauges for Mechanical Systems
20 05 29	Hangers and Supports for Mechanical Piping and Equipment
20 05 33	Heat Tracing for Mechanical Piping
20 05 48.13	Vibration Controls for Mechanical Systems
20 05 48.16	Seismic Controls for Mechanical Systems
20 05 53	Identification for Mechanical Piping and Equipment
20 05 93	Testing, Adjusting, and Balancing for Mechanical Systems
20 07 00	Mechanical Systems Insulation
20 08 00	Commissioning of Mechanical Systems

Division 21 Fire Suppression

21 11 16	Facility Fire Hydrants
21 13 00	Fire-Suppression Sprinkler Systems
21 21 00	Carbon-Dioxide Fire-Extinguishing Systems

Division 22 Plumbing

22 05 69	Facility Plumbing Services
22 11 00	Facility Water Distribution
22 11 19.13	Potable Water Copper-Silver Ionization Systems
22 13 00	Facility Sanitary Sewerage
22 15 00	General Service Compressed-Air Systems
22 33 13	Instantaneous Electric Domestic Water Heaters
22 33 33	Electric Domestic Water Heaters
22 42 00	Commercial Plumbing Fixtures

Division 23 Heating, Ventilating, and Air Conditioning

23 09 13.51	Carbon Monoxide and Nitrogen Dioxide Detection Systems
23 11 23	Facility Natural-Gas Piping
23 11 23.13	Facility Natural-Gas Metering
23 21 00	Hydronic Piping and Pumps
23 23 00	Refrigerant Piping
23 25 00	HVAC Water Treatment
23 30 00	HVAC Air Distribution
23 33 19	Duct Silencers
23 34 00	HVAC Fans
23 51 19	Fabricated Stacks
23 51 23	Gas Vents
23 52 16	Condensing Boilers
23 57 00	Heat Exchangers for HVAC
23 74 13	Packaged, Outdoor, Central-Station Air-Handling Units
23 74 23	Packaged, Outdoor, Heating-Only Makeup-Air Units
23 81 26	Split-System Air-Conditioners
23 81 29	Variable Refrigerant Flow HVAC Systems

23 81 43	Air-Source Unitary Heat Pumps
23 82 16	Air Coils
23 83 16.16	In-Floor Radiant-Heating Hydronic Piping
23 83 17	Snow Melt Radiant-Heating Hydronic Piping
23 84 00	Humidity Control Equipment

Division 24

Not Used

Division 25 Integrated Automation

25 05 01	Automatic Control Systems
25 05 02	Building Automation System
25 96 00	Integrated Automation Control Sequences for Electrical Systems

Division 26 Electrical

26 05 00	Common Work Results for Electrical
26 05 19	Low-Voltage Electrical Power Conductors and Cables
26 05 23	Control-Voltage Electrical Power Cables
26 05 26	Grounding and Bonding for Electrical Systems
26 05 29	Hangers and Supports for Electrical Systems
26 05 33.13	Conduit for Electrical Systems
26 05 33.16	Boxes for Electrical Systems
26 05 43	Underground Ducts and Raceways for Electrical Systems
26 05 44	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 44.13	Firestopping for Electrical Systems
26 05 48.13	Vibration Controls for Electrical Systems
26 05 48.16	Seismic Controls for Electrical Systems
26 05 53	Identification for Electrical Systems
26 05 73.16	Coordination Studies
26 05 73.19	Arc-Flash Hazard Analysis
26 05 83	Wiring Connections
26 08 00	Commissioning of Electrical Systems
26 08 32.16	Performance Checklist for Natural-Gas Generators
26 08 36	Performance Checklist for Automatic Transfer Switches
26 08 50	Commissioning of Lighting
26 09 19	Enclosed Contactors
26 09 23	Lighting Control Devices
26 22 13	Low-Voltage Distribution Transformers
26 24 16	Panelboards
<u>26 27 13</u>	<u>Electricity Metering</u>
26 27 16	Electrical Cabinets and Enclosures
26 27 26	Wiring Devices
26 27 26.13	Floor Box Assemblies
26 28 13	Fuses
26 28 16.02	Molded Case Circuit Breakers
26 28 16.16	Enclosed Switches
26 29 13	Enclosed Controllers
26 32 13.16	Gas-Engine-Driven Generator Sets
26 36 23.13	Bypass-Isolation Automatic Transfer Switches
26 43 13	Surge Protective Devices for Low-Voltage Electrical Power Circuits
26 51 19	LED Interior Lighting
26 52 13.13	Emergency Lighting
26 52 13.16	Exit Signs
26 56 19	LED Exterior Lighting

Division 27 Communications

27 05 28	Pathways for Communications Systems
27 05 28.01	Pathways for Communications Systems - Innerduct
27 05 28.61	Pathways for Access Control and Intrusion Detection
27 05 28.63	Pathways for Video Surveillance
27 05 36	Cable Trays for Communications Systems
27 05 44	Sleeves and Sleeve Seals for Communications Pathways and Cabling

Division 28 Electronic Safety and Security

28 08 46	Commissioning of Fire Detection and Alarm
28 46 13	Fire-Alarm Systems
28 46 15	Fire-Alarm System Sequences of Operation
28 46 21.12	Fire-Alarm Control Units
28 46 21.22	Fire-Alarm Remote Annunciators
28 46 21.24	Supervising Station Alarm Systems Communications Equipment
28 46 25	Fire-Alarm System Accessories
28 46 31	Fire-Alarm Initiating Devices
28 46 31.18	Carbon Monoxide Detection Sensors
28 46 31.31	Fire-Alarm Manual Initiating Devices
28 46 31.41	Fire-Alarm Supervisory Signal Initiating Devices
28 46 41	Fire-Alarm Notification Appliances
28 46 51	Fire-Alarm Supervised Interface Hardware
28 46 51.08	Fire-Alarm Supervised Interface Hardware for Openings
28 46 51.23	Fire-Alarm Supervised Interface Hardware for HVAC Systems
28 49 26	Emergency Call Systems for Universal Washrooms

Division 29

Not Used

VOLUME 3

SITE AND INFRASTRUCTURE SUBGROUP

Division 30

Not Used

Division 31 Earthwork

31 00 99	Earthwork For Minor Work
31 05 16	Aggregate For Earthwork
31 22 13	Rough Grading
31 22 16	Topsoil & Finish Grading
31 22 19	Finish Grading
31 23 33.01	Excavating, Trenching, And Backfilling
31 32 19.16	Geotextile Soil Stabilisation
31 63 30	Sewer Video Inspections

Division 32 Exterior Improvements

32 11 16.01	Granular Sub-Base
32 12 16	Asphalt Paving
32 16 00	Concrete Sidewalks, Curbs And Gutters
32 31 00	Fences And Gates
32 91 00	Sodding
32 92 00	Mechanical Seeding
32 92 23	Sodding
32 93 00	Trees, Shrubs & Groundcover

Division 33 Utilities

33 05 16	Maintenance Holes And Catch Basin Structures
33 14 16	Site Water Utility Distribution Piping
33 14 16	Subdrainage Piping
33 31 11	Site Sanitary Sewerage Gravity Piping
33 41 00	Storm Utility Drainage Piping

Division 34 to Division 39

Not Used

PROCESS EQUIPMENT SUBGROUP

Not Used

END OF DOCUMENT

PART 1 - GENERAL

1.1 PRICING

- .1 All costs associated with the work required by and associated with this Section shall be included as part of the Contract Price and in the price listed in item #1 of the Bid Form.

1.2 GENERAL INSTRUCTIONS

- .1 Read and conform to:
 - .1 the General Conditions and the Supplementary Conditions of the Contract;
 - .2 Division 1 requirements and documents referred to therein.

1.3 SUMMARY

- .1 Work Included: Provide concrete floor finishing including but not limited to following:
 - .1 dry shake floor hardener.
 - .2 curing and sealing.
 - .3 premoulded joint filler.
 - .4 sawcutting construction and control joints in concrete.
 - .5 caulking construction and control joints and over premoulded joint filler with sealant.
- .2 Related Requirements: Specifications throughout entirety of Divisions of this Project are directly applicable to this Section, and this Section is directly applicable to them.

1.4 REFERENCES

- .1 Reference Standards: Latest published editions of reference standards listed in this Section in effect as of closing date and time of the Request for Tenders for the Contract, including any amendments adopted, are applicable unless otherwise indicated.

1.5 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings:
 - .1 Prior to starting work of this Section, convene a pre-installation meeting at Project site to review Project requirements and site conditions with pertinent parties. Conform to requirements of Section 01 30 00.

1.6 SUBMITTALS

- .1 Product Data: Submit manufacturer's literature and data sheets for each type of material provided under this Section for the Project in accordance with requirements of Section 01 30 00. Ensure data sheets provide required information including detailed instructions for installing as well as maintaining, preserving and keeping materials in clean and safe conditions. Provide adequate warning of maintenance practices or cleaning agents detrimental to specified materials.
- .2 Safety Data Sheets (SDS): Submit SDS for inclusion in Operation and Maintenance Manual specified in Section 01 70 00, for adhesives, sealants and any other material designated by Consultant.

- .3 Maintenance Data: Submit maintenance manuals in accordance with Section 01 70 00 to the Consultant. Contribute to this manual complete, detailed and specific instruction for maintaining, preserving and keeping clean surfaces of this work and which give adequate warning of maintenance practices or materials detrimental to sealed surfaces.

1.7 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Manufacturers: Provide Products for Work of this Section by manufacturer with minimum 10 years' experience in the manufacture of such materials.
 - .2 Installers: Provide work of this Section executed by competent installers with minimum 5 years' experience in the application of the Products, systems and assemblies specified in this Section and with the approval and training of the Product manufacturers.
 - .3 Cast in place concrete and concrete materials shall be inspected and tested by a CSA certified testing laboratory.
- .2 Single Source Responsibility: Ensure primary materials provided in this Section are obtained from 1 source by a single manufacturer and secondary materials are obtained from sources recommended by primary materials manufacturers.
- .3 Mock-ups: Provide mock-ups in locations designated by Consultant and as required to demonstrate quality of workmanship. Maintain mock-ups during construction in an undisturbed condition as a standard for judging the completed work. As a minimum, Provide slab panel at least 1220 mm (4'-0") by 1525 mm (5'-0") feet and 100 mm (4") thick to demonstrate specified slab finish. Provide each slab panel with full length joint line.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Store materials on Site in manner to prevent damage thereto. Protect materials from inclement weather. Comply with CSA A23.1.
- .2 Protect materials and work of this Section from damage in accordance with CSA A23.1. Protect other work from damage resulting from this work. Replace damaged work which cannot be satisfactorily repaired.

1.9 PROJECT CONDITIONS

- .1 Temporary Lighting: Minimum 1-200 W light source, placed 2.5 m (8') above floor surface, for each 40 m² (430 sq ft) floor being finished.
- .2 During hot weather or cold weather, conform to requirements of CSA A23.1 for mixing, placement and protection of concrete in extreme weather. During cold weather, Provide temporary heating and enclosures required.

1.10 WARRANTY

- .1 The Contractor warrants the work of this Section for a period of 5 years against defects and/or deficiencies in accordance with General Conditions of the Contract. Promptly correct any defects or deficiencies which become apparent within this 5 year warranty period, to the satisfaction of the Consultant and at no expense to the Owner. Defects include but are not limited to: failure of floor finish to remain in place, bonding failure, finish becoming defective, spalling and/or cracking.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 Products of following manufacturers (or equivalent) may be acceptable subject to conformance to requirements of Drawings, schedules and Specifications:
 - .1 Adsil Advanced Silane Technology.
 - .2 Advanced Floor Products, Inc.
 - .3 ChemRex Inc.
 - .4 CPD Construction Products
 - .5 Day1 (Solomon Colors)
 - .6 Euclid Chemical
 - .7 PROSOCO.
 - .8 Sika Canada Inc.
 - .9 W.R. Meadows of Canada
- .2 Substitution Limitations: Comparable Products from manufacturers listed herein offering functionally and aesthetically equivalent Products in Consultant's opinion and subject to Consultant's review, will be considered provided they meet the requirements of this Specification.

2.2 DESCRIPTION

- .1 Design and Performance Requirements:
 - .1 Concrete finishing shall comply with applicable CSA and ACI standards and best practices whether specifically listed in this Section or not. Generally, perform Work in accordance with CSA-A23.1/A23.2.
 - .2 Place cast-in-place concrete of appropriate properties for intended use in accordance with requirements of applicable CSA-A23.1/A23.2 for applicable concrete exposure class and content of mix. Refer to Section 03 30 00.
 - .3 Coordinate with finish flooring supplier and installer to ensure adequate slab flatness is provided for floor finish scheduled to be installed on slab.
 - .4 Finish concrete floors with a smooth, dense, steel trowel finish to achieve the following tolerances per CSA-A23.1/A23.2 (Table 22)
 - .1 For surfaces scheduled to have thick-set tile, for concrete surfaces exposed to view (sealed concrete) in back-of-house areas, under raised flooring, and unless otherwise indicated: Class A (Overall FF 20 and FL 15)
 - .2 Under resilient finishes and other flooring less than or equal to 3 mm thick: Class B (Overall FF 25 and FL 20)
 - .3 Under thin-set flooring (tiling), and concrete surfaces exposed to view (sealed concrete) in public areas: Class C (Overall FF 30 and FL 25)
 - .4 At helicopter hangar: Class D (Overall FF 50 and FL 40)
 - .5 Repair cracks in concrete floors to suit the floor finish and long-term serviceability requirements of floor.
 - .6 Tolerances: Construct forms to produce plumb and level concrete and true to linear building lines. Conform to CSA A23.1, Clause 6.4 for maximum variations (not accumulative).

- .7 Static Coefficient of Friction: Ensure floor surfaces are stable, firm and slip resistant after completing finishing procedures (where exposed). Provide Products with the following minimum values as determined by ASTM D2047 unless otherwise indicated:

- .1 Level Surfaces: Minimum 0.6.
- .2 Ramp Surfaces: Minimum 0.8.

2.3 MATERIALS

- .1 Dry-shake Floor Hardener: Provide factory-mixed, ready-to-use dry shake floor hardener. Ensure items are delivered to the Site in sealed, moisture resistant bags, ready to apply, finish and cure.
 - .1 Non-Metallic Quartz Hardener: Provide 1 of following:
 - .1 "Surflex" by Euclid Chemical,
 - .2 "Maximent HD" by ChemRex Inc.,
 - .3 "Diamag 7" by Sika Canada Inc.
 - .2 Use in following locations: Exposed 'sealed' concrete floors subject to wheel traffic ~~-(sally port) and helipad. Do not use on floors subject to steel wheels.~~
- .2 Liquid Densifier/Sealer and Dustproofing Compound (SLR): "LS/CS-SCS Indoor Gold" by PROSOCO, or "Liqui-Hard" by W.R. Meadows Inc. or equivalent ~~meeting LEED v4 emissions criteria.~~
 - .1 Gloss Level: Low sheen
 - .2 Film Forming Protective Treatments: Follow application of penetrating concrete floor densifier with minimum of two coats of general-purpose medium gloss, film forming sealer to treat surfaces to increase resistance damage from water, staining, and abrasion.
 - .1 Basis-of-Design: "Bellatrix" by W.R. Meadows Inc. or approved equivalent.
 - .3 Use in following locations: Where interior horizontal concrete slabs are indicated on Drawings and Schedules to be 'sealed' or marked as 'exposed'. Do not use on floors exposed to water, salts and inorganic acids.
- .3 Joint Sealants: In accordance with performance requirements of Section 07 92 00.
 - .1 Standard Joint Sealant: 2 component, chemically reactive polyurethane modified sealant over premoulded joint filler; self-levelling, grey colour. Provide 1 of following:
 - .1 Vulkem 245 by Tremco, or equivalent ~~meeting LEED v4 criteria.~~
 - .2 Heavy Duty Sealant for Sawcut Joints: Epoxy modified joint sealant, cold-applied, 2 component, pour grade self levelling compound with minimum Shore A Hardness of 80 and Shore D Hardness of 50.
 - .1 Loadflex by Sika Canada Inc., or equivalent ~~meeting LEED v4 criteria.~~
 - .3 Backer Rod: Extruded, closed cell, circular polyethylene foam, sized 25% larger than joint width into which it will be installed.
- .4 Miscellaneous Materials:
 - .1 Water for Curing: Water conforming to CSA A23.1, Clause 7.4.1 clear and entirely free from any elements which might cause staining of concrete.
 - .2 Polyethylene Film (for Water Curing): Minimum 0.1 mm (4 mils) thick, complying with maximum allowable moisture loss requirements of ASTM C156.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Site Verification of Conditions: Verify actual site dimensions and location of adjacent materials prior to commencing work. Notify Consultant in writing of any conditions which would be detrimental to the installation. Commencement of work implies acceptance of previously completed work.

3.2 PREPARATION

- .1 After concrete has been placed, strike off concrete level and flush to screeds with true straight edge.
- .2 Immediately after striking off concrete, level and consolidate with wooden darby or bull float. Complete levelling and consolidation before free moisture (bleeding) rises to surfaces.
- .3 Wait until concrete stiffens sufficiently to sustain foot pressure with only about 6 mm (1/4") indentation.
- .4 Float concrete with hand float or with power float. If free bleeding water remains on surface at this time, remove it before floating.

3.3 INSTALLATION

- .1 Floor Finishing:
 - .1 Laser screed floor slabs as scheduled herein, using laser screed vehicle. Laser vibratory screed is to be operated only by trained and qualified personnel who are familiar with equipment.
 - .2 Power screed interior floor slabs with mechanical vibratory screeding equipment. Machine float and machine trowel floor surfaces to smooth, level and dense surfaces free from trowel marks, ridges and depressions, except where specified otherwise.
 - .3 Power screed exterior floor slabs with mechanical vibratory screeding equipment. Float using magnesium floats and trowel to level and dense surfaces and finish to sidewalk "swirl" texture.
 - .4 Use hand held vibrators and hand screed, float and trowel areas where power equipment is inaccessible, to same density and surface quality specified in Contract Documents for floors finished with power operated equipment.
 - .5 For concrete mixes containing steel fibre reinforcement, ensure finishing process leaves surface free of protruding fibres. If fibres protrude from surface after concrete has set, remove protruding fibres by grinding.
- .6 Non-Metallic Quartz Hardener:
 - .1 In areas indicated to receive non-metallic quartz hardener, power screed floor slab and float.
 - .2 Over floated concrete (at plastic stage), apply premixed non-metallic quartz shake in 2 equal applications at right angles to total application rate of 7.5 kg/m² (1.5 lbs/sq ft) of floor area. Distribute evenly. Do not throw shake. Float between application of shake and after second shake application with power float. Machine trowel to smooth, level and dense surface, in uniform colour, free from trowel marks, ridges, pinholes and other defects.

- .7 Liquid Densifier/Sealer and Dustproofing Compound: In areas to receive penetrating floor sealer, prepare surfaces as recommended, mix and apply at rate of application in accordance with manufacturer's recommendation.
- .8 Miscellaneous Finishes:
 - .1 In areas specified to receive subsequent epoxy or urethane floor overlay or coating, finish concrete floor surface with 1 pass steel trowel.
 - .2 Swirled Finish: In final trowelling of Steel Trowel Finish, where swirled finish is scheduled, impart slightly textured surface to concrete by spin trowelling.
 - .3 Install abrasive nosings to stair treads prior to placement of concrete and hand trowel treads to swirl, non-slip surface.
- .2 Sawcutting of Control Joints And Construction Joints:
 - .1 Saw cut control joints (contraction joints) to CSA-A23.1/A23.2, 24 hours maximum after placing of concrete, and before concrete develops random contraction cracks. Do not postpone sawing operations beyond these time limitations.
 - .2 Refer to Section 03 30 00 for joint requirements for structural work. For other requirements, provide control joints in unreinforced slabs, spaced at maximum 4.5 m (14.76 ft) on centre in square patterns.
 - .3 Construct control joints for a depth equal to no more than one-fourth of concrete thickness. Do not cut through reinforcement, heating systems and other embedded items.
 - .4 Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades, minimum 3 mm (1/8 inch) wide, ensuring cutting action will not tear, abrade, or otherwise damage surface.
 - .5 Continuously spray water on saw blade during sawing. Grind edges of sawcuts to eliminate burrs; do not grind to bevel or chamfer joint edges.
 - .6 After sawing and grinding, clean joints with jet of water and blow-out with compressed air. Immediately broom clean, residue caused by sawing operation as work progresses.
 - .7 When cleaned joints are dry and prior to traffic being allowed over area, install temporary filler using polyethylene rope in such joints to prevent contamination.
 - .8 Install joint-filler strips at junctions with slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated on Drawings and Schedules.
 - .9 Do not fill isolation joints, construction joints and control joints sooner than 120 Days after concrete placement. Execute joint sealing during cool, dry ambient conditions when slab is in contracted state to minimize future joint separation at sealant filled joints.
 - .10 Ensure joints are clean and sound. Remove oil, dirt, debris, paint and other materials that may be a bond breaker. Remove temporary filler from sawcut joints. Clean joints and blow with compressed air.
 - .11 Extend joint fillers full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated on Drawings and Schedules. Overfill joints during placement. Cut flush or grind flush with floor within 24 hours after placement.
- .3 Curing/sealing of Floors:
 - .1 Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with CSA A23.1/A23.2 for cold-weather protection and hot-weather protection during curing.
 - .2 Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

- .3 Curing Methods: Cure formed and unformed concrete for at least seven days, or until minimum structural strength of concrete indicated in Section 03 30 00, and as required by CSA A23.1/CSA 23.2 (Table 2) for exposure class and floor finishes specified.
- .4 Joint Sealant:
 - .1 Following joint sealant installation Specifications, do not apply in areas of concrete slab to receive subsequent floor finishes such as quarry tile, ceramic tile, carpet, resilient tile and epoxy topping system.
 - .2 Do not fill isolation joints, construction joints and control joints sooner than 120 Days after concrete placement. Execute joint sealing during cool, dry ambient conditions when slab is in contracted state to minimize future joint separation at sealant filled joints.
 - .3 Remove temporary filler from sawcut joints. Remove 6 mm (1/4") scored strip from top of premoulded joint filler. Clean joints and blow clean with compressed air.
 - .4 Reinstall backer rod into construction/expansion joints, set to proper sealant depth per sealant manufacturer's printed directions. Fill remainder of joint with standard joint sealant.
 - .5 No sooner than 120 Days, fill interior sawn construction and control joints in concrete slabs full depth with heavy duty sawcut joint sealant in accordance with manufacturer's printed directions. Joints must be overfilled with sealant and then shaved flush with slab surface once hardened.
 - .6 Caulk over premoulded isolation joint fillers with specified standard joint filler sealant.
 - .7 Prime wall of joint as recommended by sealant manufacturer. Mix sealant as directed by manufacturer. Coat surfaces of metal in contact with sealant with primer as recommended by sealant manufacturer.
 - .8 Fill exterior sawn construction and control joints and over premoulded isolation joint filler with specified standard joint sealant.
 - .9 Comply with manufacturer's application and substrate temperature requirements.

3.4 REPAIR/RESTORATION

- .1 Crack Repair:
 - .1 After concrete has cured, examine concrete floor surfaces and repair cracks. Route cracks out with mechanical router to minimum depth of 13 mm (1/2"). Then clean and fill cracks in same manner as control joints.
 - .2 Correct defects in defined traffic floor only by grinding or removal and replacement of defective slabs. Areas requiring corrective work will be identified by Consultant. Verify corrected areas with Consultant.
- .2 Perform corrective work at times convenient to the Consultant and at no cost to the Owner.

3.5 FIELD QUALITY CONTROL

- .1 Employ services of a trained concrete technician from staff of surface hardener manufacturer to give assistance to this Section in proper use of material during initial periods of installation.
- .2 Give 5 (five) Days' notice to surface hardener manufacturer in advance of commencing work.
- .3 Independent inspection and testing company may be appointed and paid for by the Owner to carry out inspection and testing as directed by the Consultant.
- .4 Perform tests in accordance with CSA A23.2.

- .5 Forward inspection company's reports of tests to the Consultant with opinion or reason for any abnormalities noted thereon.
- .6 Cooperate with and assist Inspection Company's personnel during inspection and tests.
- .7 Remove defective materials and completed work which fail tests and replace as directed by the Consultant.

3.6 FLOOR FINISHING SCHEDULE

Scheduled Floor Finish	Concrete Finish Required	Hardener	Curing/Sealing Method*
Carpet	Steel Trowel	None Required	Dissipating curing compound or water or poly curing.
Resilient Flooring	Steel trowel followed by blastrack.	None Required	Dissipating curing compound (where approved by flooring manufacturer), or water or poly curing
Trowel Applied Composition Flooring (Epoxy, Urethane Acrylic, Polyester):	Steel trowel followed by blastrack in accordance with CSA A23.1.	If recommended by composition flooring material manufacturer	Poly curing
Liquid Applied Rubber or Plastic Membrane (Mechanical Waterproofing):	Steel trowel in accordance with CSA A23.1	None required	Water or poly curing
Thinset Ceramic and Quarry Tile, Clay Tile and Brick Tile	Steel trowel in accordance with CSA A23.1	None required	Water or poly curing
Ceramic and Quarry Tile, Clay Tile and Brick Tile over mortar bed	Steel trowel followed by blastrack in accordance with CSA A23.1	None required	Water or poly curing
Exposed Concrete – <u>Interior</u>	Steel trowel in accordance with CSA A23.1.	Non-Metallic Quartz Hardener	Curing/sealing compound
<u>Exposed Concrete – Exterior</u>	<u>Nonslip Broom Finish (final texture to be determined in coordination with the Owner)</u>	<u>Non-Metallic Quartz Hardener</u>	<u>Curing/sealing compound</u>

- .1 * Curing/Sealing Method: Refer to room finish schedule for specific types of sealers required on exposed concrete floors.
- .2 ** Exposed concrete finishes: Provide swirled finish where concrete is scheduled to be exposed at ramps or in staircases.

END OF SECTION

PART 1 - GENERAL

1.1 PRICING

- .1 All costs associated with the work required by and associated with this Section shall be included as part of the Contract Price and in the price listed in item #1 of the Bid Form.

1.2 GENERAL INSTRUCTIONS

- .1 Read and conform to:
 - .1 the General Conditions and the Supplementary Conditions of the Contract.
 - .2 Division 1 requirements and documents referred to therein.

1.3 SUMMARY

- .1 Work Included: Provide architectural woodwork including but not limited to following:
 - .1 architectural cabinet casework.
 - .2 architectural cabinet casework drawers and doors.
 - .3 edgebanding for architectural cabinet casework and doors.
 - .4 edgebanding for architectural cabinet shelves on visible and semi-exposed edges.
 - .5 Countertops with integral sinks.
 - .6 architectural cabinet casework hardware.
 - .7 closet and utility shelving.
 - .8 trim and mouldings.
- .2 Related Requirements: Specifications throughout the entirety of Divisions of this Project are directly applicable to this Section, and this Section is directly applicable to them.

1.4 REFERENCES

- .1 Definitions:
 - .1 In the context of architectural cabinetry, the following definitions apply (and shall be used in this Section) in accordance with North American Architectural Woodwork Standards (NAAWS), Section 10 and amended as follows:
 - .1 Exposed Surfaces: Defined as all surfaces exposed to view in open casework or behind transparent doors. These include:
 - .1 Surfaces visible when doors and drawers are closed, including knee spaces.
 - .2 Underside of cabinet bottoms over 1067 mm (62") above finished floor level, including cabinet bottoms behind light valances and bottom edge of light valances.
 - .3 Cabinet tops under 2032 mm (80") above finished floor, or if 2032 mm (80") and over and visible from an upper building level or floor.
 - .4 Front edges of stretchers, ends, divisions, tops and bottoms.
 - .5 Sloping tops of cabinets that are visible.
 - .6 Shelves (including edgebanding).
 - .7 Divisions and partitions.

- .8 Interior face of ends (sides), backs, and bottoms (including pull-outs). Also included are the interior surfaces of cabinet top members 914 mm (36") or more above the finished floor.
- .9 Interior face of door and applied drawer fronts.
- .2 Semi-Exposed Surfaces: Defined as those interior surfaces only exposed to view when doors or drawers are opened. These include:
 - .1 Tops and bottoms shelves, including front edgebanding (front edge is considered exposed).
 - .2 Divisions and partitions (front edge is considered exposed).
 - .3 Interior face of ends (sides), backs, and bottoms (including pull-outs). Also included are the interior surfaces of cabinet top members 914 mm (36") or more above the finished floor.
 - .4 Drawer sides, sub-fronts, backs, and bottoms.
 - .5 The underside of cabinet bottoms between 610 mm (24") and 1067 mm (42") above the finished floor.
 - .6 Security and dust panels or drawer stretchers.
 - .7 The faces of cabinet ends of adjoining units that butt together.
- .3 Concealed Surfaces: Defined as those exterior or interior surfaces that are covered or not normally exposed to view. These include:
 - .1 Toe space unless otherwise specified.
 - .2 Sleepers, stretchers, and solid sub-tops.
 - .3 The underside of cabinet bottoms less than 610 mm (24") above the finished floor.
 - .4 The flat tops of cabinets 2032 mm (80") or more above the finished floor, except if visible from an upper floor or building level.
 - .5 The three non-visible edges of adjustable shelves.
- .2 Reference Standards: Latest published editions of reference standards listed in this Section in effect as of the closing date and time of the Request for Tenders for the Contract, including any amendments adopted, are applicable unless otherwise indicated.

1.5 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings:
 - .1 Prior to starting work of this Section, convene a pre-installation meeting at the Project site to review Project requirements and site conditions with pertinent parties. Conform to requirements of Section 01 30 00.
- .2 Coordination:
 - .1 Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that architectural woodwork and related items can be supported and installed as indicated.
 - .2 Perform pre-wiring and partial mounting of electrical and audio/visual equipment and concealed wiring required. Finalize location of outlets and similar items with the Consultant prior to installation.
 - .3 Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings.
 - .4 Coordinate fabrication schedule with construction progress and the Construction Schedule to avoid delaying the Work.

- .5 Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.6 SUBMITTALS

- .1 Product Data: Submit manufacturer's literature and data sheets for each type of material provided under this Section for the Project in accordance with requirements of Section 01 30 00. Ensure data sheets provide required information including detailed instructions for installing as well as maintaining, preserving and keeping materials in clean and safe conditions. Provide adequate warning of maintenance practices or cleaning agents detrimental to specified materials.
- .2 Safety Data Sheets (SDS): Submit SDS for inclusion in Operation and Maintenance Manual specified in Section 01 70 00, for adhesives, sealants and any other material designated by Consultant.
- .3 Shop Drawings:
 - .1 Submit Shop Drawings indicating material characteristics, details of construction, connections and relationship with adjacent construction.
 - .2 Indicate locations and sizes of cutouts and holes for plumbing and electrical fixtures, lavatories and similar items required in architectural woodwork; coordinate with appropriate trades.
 - .3 Clearly indicate material being supplied and show connections, attachments, reinforcing, anchorage and location of exposed fastenings in accordance with NAAWS Section 1.
 - .4 Field Measurements: Take field measurements prior to preparation of Shop Drawings and fabrication to ensure proper fitting of work. Do not proceed with fabrication until Shop Drawings have been reviewed.
- .4 Samples: Submit samples in accordance with Section 01 30 00 in following sizes:
 - .1 minimum 300 mm (12") long x 460 mm (18") wide x 25 mm (1") thick solid wood.
 - .2 minimum 300 mm (12") square and of specified thickness, plastic laminate or wood veneer as applicable, mounted on 19 mm (3/4") core and finished as specified. Submit samples for Consultant's approval prior to fabrication.
 - .1 For each colour of plastic laminate or wood veneer species selected (as applicable), submit manufacturer's standard 300 mm x 460 mm (12" x 18") chips.
 - .3 minimum 300 mm (12") square x 13 mm (1/2") thick countertop materials.
 - .4 each type of hardware.
- ~~.5 Certificates:
 - ~~.1 Submit Architectural Woodwork Manufacturers Association of Canada (AWMAC) Guarantee Certificate which covers replacing, reworking and refinishing of defects due to faulty workmanship or defective materials which become apparent within 2 years following date of Substantial Performance of the Work.~~
 - ~~.2 Submit final inspection report prepared by AWMAC inspection under Guarantee Inspection Service (GIS).~~~~

1.7 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Manufacturers: Provide Products for Work of this Section by manufacturer with minimum 10 years' experience in the manufacture of such materials.

- .2 Installers: Provide Work of this Section executed by competent installers with minimum 5 years' experience in the application of the Products, systems and assemblies specified and be a member of AWI/AWMAC in good standing for the previous 2 years.
- .3 Metal Fabricator: Provide metal work of this Section performed by firm capable of producing the required Shop Drawings of quality levels that are necessary to meet the requirements specified herein. Ensure the retained fabricator possesses modern architectural metal fabricating equipment capable of doing cutting, fitting, bending and installing of steel and stainless steel finishes.
- .4 Welders: Welding shall be performed by welders having minimum certification requirements of CSA W47.1 to suit the type of welding performed. Ensure welders are familiar with welding procedures for welding steel and aluminum.
- .2 Single Source Responsibility: Engage a qualified woodworking firm to assume undivided responsibility for production and installation for the Work described in this Section.
- ~~.3 Guarantee and Inspection Service (GIS):~~
 - ~~.1 Subject architectural wood work of this Section to inspection at plant and at Site by appointed inspector approved by local AWMAC Chapter. All costs attributable to GIS shall be included in the Contract Price.~~
 - ~~.2 The GIS process non-exhaustively includes the following:~~
 - ~~.1 review of Shop Drawings to determine methods and materials conform to specified standards;~~
 - ~~.2 review of mock-ups to establish quality control standards;~~
 - ~~.3 detailed inspection of manufactured components to verify their adherence to Shop Drawings, approved mock-ups and conformance to AWMAC - NAAWS.~~
- .4 Mock-ups: Provide mock-ups in locations designated by the Consultant and as required to demonstrate quality of workmanship. Maintain mock-ups during construction in an undisturbed condition as a standard for judging the completed work. Approved mock-ups may become part of completed work if the mock-up remains undisturbed at the time of Substantial Performance of The Work. Provide mock-ups for following items:
 - .1 Basic cabinetry consisting of one base cabinet, one wall hung cabinet, and one countertop. Base cabinet to have minimum one drawer.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Delivery and Acceptance Requirements:
 - .1 Do not deliver finished Products during rainy or damp weather.
 - .2 Do not deliver Work of this Section until the building and storage areas are sufficiently dry to ensure Products will not be damaged by changes in relative humidity and moisture content. Deliver, store and handle Products of this Section in accordance with NAAWS Section 2.
 - .3 Do not deliver and Install damaged Products. Replace damaged Products in accordance with requirements of this Section.
 - .4 Storage and Handling Requirements: Cover and protect finished surfaces with heavy Kraft paper and other acceptable means. Put in cartons for protection. Do not remove protective covers until immediately prior to final cleaning.

1.9 SITE CONDITIONS

- .1 Ambient Conditions: Ensure conditions conform to requirements of NAAWS Section 2 and moisture contents of wood for interior locations at time of installation are at established Optimum Moisture Content and Optimum Indoor Relative Humidity as outlined in NAAWS Section 2.

1.10 WARRANTY

- .1 The Contractor warrants the work of this Section for period of 3 years from the date of Substantial Performance of the Work against defects and deficiencies in accordance with General Conditions of the Contract. Promptly correct defects or deficiencies which become apparent within this warranty period, to the satisfaction of the Consultant and at no expense to the Owner. Defects include but are not limited to: delamination of plastic laminate, opening of seams, warpage and extensive colour fading.

PART 2 - PRODUCTS

2.1 DESCRIPTION

- .1 Regulatory Requirements:
 - .1 Provide work of this Section in accordance with North American Architectural Woodwork Standards (NAAWS), except as specified otherwise herein. Any reference in this Section to grades and any use of terminology that is capitalized herein but not otherwise defined in the Contract Documents shall have the definitions given to such grades and terminology in "NAAWS" (and such definitions are hereby, by reference, made a part of this Section). The requirements of this Section govern and modify NAAWS.
 - .2 Fire-Test-Response Characteristics:
 - .1 Where fire-retardant materials are indicated, Provide materials with specified fire-test-response characteristics as determined by a testing and inspecting agency acceptable to Authorities Having Jurisdiction.
 - .2 Identify materials with appropriate markings of applicable testing and inspecting agency on surfaces of materials that will be concealed from view after installation.
 - .3 Flame-spread index shall be in accordance with OBC requirements when tested according to CAN/ULC-S102.
- .2 Design and Performance Requirements:
 - .1 Architectural Drawings and details are diagrammatic and are only intended to show design concept, aesthetics, interfacing requirements, configuration, components and arrangements. They are not intended to identify or solve completely problems of thermal and structural movements, assembly framing, engineering design, fixings and anchorages.
 - .2 Ensure millwork casework (e.g. countertops, wall cabinets, cabinet drawers and similar items) are capable of supporting structural loads without deflection in accordance with Casework Integrity Tests in Appendix A of AWMAC- NAAWS Standard Manual of the current edition as at the closing date and time of the Request for Tenders for the Contract.
 - .3 All composite wood Products and laminating adhesives used in millwork shall not contain added urea-formaldehyde resins.
 - ~~.4~~ Adhesives shall be non-toxic, low VOC, non-solvent glue to comply with AWMAC Quality Standards Manual, ~~Canadian Eco-Logo' program, and LEED requirements.~~

- .5 All cabinets shall be flush overlay construction.
- .6 Design millwork so that no sharp edges are exposed. Provide minimum 25 mm radiused corner to countertops.
- .7 All cabinets doors and drawers shall be provided with locks as indicated on the Drawings. Key in accordance with the requirements to be provided by the Owner to the Contractor.
- .8 Incorporate all required mechanical, electrical and communication services into millwork so that wires and pipes are hidden from view. Provide access panels to all services to allow for future adjustment.
- .9 Provide built-in valance lighting underneath all upper cupboards over counter tops.
- .10 All architectural woodwork hardware shall be stainless steel of durable quality to meet standards of AINSI/BHMA grade 1 Cabinet Hardware.
- .11 All door, drawer and other exposed millwork edges shall have applied appropriately sized PVC edge strip, heat applied.
- .12 Plastic laminate-to-plastic laminate edges are not permitted.
- .13 Provide marine-grade plywood to all bottoms of sink cabinet boxes and areas that may come into contact with water.
- .14 Minimum nominal thickness and material for cabinet components and shelf deflection, type of materials, thicknesses, span width and total load distribution: In accordance with AWMAC-NAAWS Standard Manual Section 10, current edition.
- .15 Minimum nominal thickness and material for cabinet components and shelf deflection, type of materials, thicknesses, span width and total load distribution: In accordance with NAAWS Section 10.
- .3 Framing Lumber (Concealed Framing): Softwood or hardwood lumber as specified in this Section of uniform grain and colour, free from sap, shakes, knots, splits and other defects with grade marked by NLGA and meeting CAN/CSA O141 requirements as applicable. No cross grain permitted. Provide concealed wood of the most appropriate grade required to satisfy fabrication, utility and structural requirements.
- .4 Architectural Lumber (Exposed framing, solid members and trim): Clear, straight, kiln dried, hardwood lumber as specified in this Section, of species indicated on Drawings. Provide lumber kiln-dried to moisture content recommended by AWS, free from blemishes that would be apparent after finish is applied. Where species are not indicated on the Drawings, provide:
 - .1 Transparent Finish: Maple, quarter sawn, Premium grade, matched for compatibility of grain and colour.
 - .2 Opaque Finish: Natural Birch, quarter sawn, Premium grade.
- .5 Panel Products: Conform to the requirements of AWMAC AWS Section 4.
 - .1 Medium Density Fibreboard Core (MDF): All wood core substrates shall be MDF unless used in areas subject to moisture. Provide MDF Products manufactured from 100% recycled materials, without the use of added formaldehyde resins and with the following characteristics:
 - .1 Minimum density: 770 kg/m³ (48 lb. /cu ft.)
 - .2 Surface characteristics: In accordance with ANSI/NPA A208.2
 - .3 Grade: Minimum 155.
 - .4 Finish and Texture: To match the Consultant's sample.
 - .5 Where indicated, Provide industrial grade MDF certified to meet Class 1 surface burning characteristics of CAN/ULC-S102 and UL 723 with maximum Flame Spread rating of 25 and maximum Smoke Developed of 200.

- .6 Acceptable Products:
 - .1 Medium Density Fibreboard Core (MDF): Decorative panels, "Medite II®" by Sierra Pine Ltd; or equivalent Products manufactured by Flakeboard Company Limited; Uniboard Canada Inc.; or Tafisa Canada and Company, Ltd.; (or Equivalent)
 - .2 Veneer Core (Plywood): Provide exterior grade, veneer core (plywood) at countertop cores and splashes where sinks are scheduled to be installed and at other locations as required to meet design requirements. Provide fire-retardant treatment as required to meet OBC stipulations. Conform to AWS Section 4.
 - .1 Softwood plywood (rough framing and rough carpentry only):
 - .1 Premium Grade, Douglas Fir plywood - CSA O121, or Western Softwood Plywood - CSA O151 or Poplar plywood - CSA O153-M. Provide Grade G2S where exposed on two sides and Grade G/Solid where exposed on one side. Consider fitment doors exposed on both sides.
 - .2 Hardwood Plywood (wood cores): Conforming to the requirements of ANSI/HPVA HP-1.
 - .1 Water-resistant plywood "PureBond™" by Columbia Forest Products; or "HyBrid Panel – SkyPly" by Rosenberg Forest Products; (or Equivalent).
 - .3 Provide veneer core (plywood) for following applications:
 - .1 millwork cores subject to moisture,
 - .2 cabinet bases in contact with floor, and
 - .3 countertop cores in other locations designated on the Drawings.
- .6 Facings:
 - .1 Facing Adhesive: As recommended by the manufacturer and containing no added urea-formaldehyde. Provide water-resistant adhesive for areas subject to moisture.
 - .2 High Pressure, Paper Base, Decorative Laminates:
 - .1 Fire-Test Response Characteristics: Ensure decorative laminates meet flame spread requirements for Class A (Class I) rating in accordance with CAN/ULC S102.2. Flame spread index: < 25; Smoke developed Index: 0.
 - .2 Provide following types and thicknesses conforming to ANSI/NEMA LD3 and ANSI/NEMA LD3.1 and AWS Section 4:
 - .1 Horizontal General Purpose: HGS - 1.2 mm (0.048").
 - .2 Vertical General Purpose: VGS - 0.7 mm (0.028").
 - .3 Postforming Horizontal: HGP - 1.0 mm (0.039").
 - .4 Postforming Vertical: VGP - 0.7 mm (0.028").
 - .5 Backer Sheet: BKM - 1.0 mm (0.039").
 - .3 Plastic Laminate Types (PLAM):
 - .1 Products of the following manufacturers (or Equivalent manufacturers) are acceptable subject to conformance to the requirements of the Contract Documents:
 - .1 Arborite High Pressure Laminates;
 - .2 Pionite Decorative Laminates

- .2 Colours and Finishes: To be selected by the Consultant at a later date from the manufacturer's full colour range including solid and woodgrain patterns, including cross-grain patterns and printed patterns in suede or matte finishes.
 - .1 Maximum Number of Colours, Finished and Patterns: 5.
- .7 Architectural Woodwork Hardware and Accessories:
 - .1 Provide hardware meeting or exceeding the applicable ANSI/BHMA A156 Series (Grade 1) standards.
 - .2 Slides:
 - .1 Heavy Duty Drawer Slides – more than 610 mm (24") wide, Capacity: 68.04 kg (150 lbs)
 - .1 Side Mounted Telescoping Ball Bearing drawer slide with full extension and 25 mm (1") overtravel (length as required to suit the drawer size). Provide one of the following (or Equivalent):
 - .1 Model No. Accuride – 3640 by Hafele America Company
 - .2 Model No. 8505 by Knappe & Vogt Canada Inc.
 - .3 Model No. KA 555 by Hettich Canada Ltd.
 - .3 Cabinet Door Hinges and Stays:
 - .1 Ensure cabinet hinge pin is not removable (tack weld or cap). Provide hinges complete with one-piece non-removable pin with tapered tips
 - .2 Wood Door Hinges:
 - .1 Frameless Concealed Hinges (European Type) – 165° to 170° opening: Self-closing concealed hinges with integrated soft close. Manufacturer's recommended number of hinges shall suit the door size and thickness. Provide one of the following:
 - .1 "Salice Concealed Wide Angle Hinges - No. 329.07 Series" by Hafele America Company.
 - .2 "Blum Concealed - Clip-Top Hinge" by Richelieu Hardware Ltd.
 - .3 "Intermat 9943" or "Intermat 9956" by Hettich Canada Ltd.
 - .4 or Equivalent to the above.
 - .2 Piano Hinges: Stainless steel. Provide hinges in the manufacturer's recommended size and length to suit door size and thickness.
 - .1 "Model No. 351.10 series" by Hafele America Company or Equivalent. Finish: AISI No. 4, Satin Finish.
 - .4 Door and Drawer Locks:
 - .1 Lock locations are noted Drawings. Provide locks in accordance with the Owner's keying requirements unless otherwise indicated in the Contract Documents.
 - .2 Wood Framed Doors and Drawers:
 - .1 Cylinder Locks: Provide adjustable locking system with lock throw, orientation and size to suit cabinet size. Provide one of the following:
 - .1 "Cylinder Module System; Model No. 232 Series" by Hafele America Company complete with cam locks or deadbolt locks and cores as required to suit applications indicated.

- .2 "Disc Tumbler Furniture Locks - Removacore" by CompX International Inc. complete with cam locks or deadbolt locks and cores as required to suit applications indicated .
- .5 Handles (Doors and Drawers):
 - .1 D-Pulls: Provide one of the following:
 - .1 "Model No. "Furniture Handle 10 mm 562.10.96" by Hewi or Equivalent.
 - .2 Finish: to be selected by Consultant at a later date.
- .6 Recessed Shelf Pilasters, Standards and Clips:
 - .1 Provide required accessories to mount wood shelves. Provide one of the following:
 - .1 "KV255" pilaster and "KV256" adjustable clip supports by Knappe & Vogt Canada Inc.
 - .2 "120-10 Series" pilasters and "1903-2G" clip supports by Richelieu Hardware Ltd.
- .7 Door and Drawer Stops, Bumpers and Catches:
 - .1 Drawer and Hinged Door Bumpers: Provide two clear resilient, press-fit bumpers per door or drawer.
 - .2 Built-in Drawer Stops: Resilient type recommended by the manufacturer.
 - .3 Magnetic Door Catch: Holding Power: 3 kg to 4kg (6.6 lbs to 8.8 lbs) Finish: Heavy duty cast aluminum. Provide one of the following (or Equivalent):
 - .1 Model No. 246.26 Series by Hafele America Company
 - .2 Model No. 918 by Knappe & Vogt Canada Inc.
- .8 Spring Latch (workstation 155):
 - .1 Provide Steel and Nylon spring catch and strike where indicated on Drawings; "Spring Catch, 32 mm, Press-In Strike – 245.07.711" by Hafele (or Equivalent).
- .8 Cable Management Grommets: Provide 54 mm (2-1/8") diameter grommets in numbers indicated at locations shown on reviewed Shop Drawings. Finish: to be selected at a later date.
 - .1 "Flip Top Series", by Mockett;
 - .2 "Round Plastic Cable Grommets; Model No. 429.9 Series" by Hafele.
 - .3 or Equivalent to the above.
- .9 Waste Receptacle Ring:
 - .1 Provide 200mm diameter, Stainless Steel surface mounted waste chute where indicated on drawings; "61436171" by Richelieu or TM1B – 6" Trash Grommet by Mockett (or Equivalent).
- .10 Closet Coat Rods: "KV660" by Knappe and Vogt Manufacturing Company (or Equivalent), 27 mm (1-1/16") od stainless steel rod complete with "KV734 – Full Circle" polished chrome flanges. Size rods to suit closet widths.
- .11 Solid Polymer Surfacing (SPS): Section 06 61 16.
- .12 Fastenings:
 - .1 Include the necessary fastenings, anchors and accessories required for fabrication and erection of the Work of this Section.
 - .2 Fastenings include non-exhaustively: anchor bolts, machine bolts, toggle bolts, male/female bolts, lag screws, expansion shields, sleeves, brackets, washers and nuts.

- .3 Provide exposed fasteners, where approved and shown on reviewed Shop Drawings, of the same texture, colour and finish as the base material on which they occur unless otherwise shown or noted in the Contract Documents. Use only stainless steel fasteners with stainless steel components.
- .4 Supply bolts complete with washers and nuts required for complete installation. Provide lock washers where vibration may loosen bolted fastenings.
- .5 Ensure thread dimensions are such that nuts and bolts fit without rethreading or chasing threads.
- .6 Bevelled hexagon head bolts: ASTM A307.
- .7 Bonding Cements: Achieve with solvents or adhesives, suitable for use with Product and application.

2.2 COMPONENTS

- .1 Casework and Frames Construction: Conforming to AWS Section 10 unless otherwise indicated in the Contract Documents. Provide Premium grade quality construction and finishing unless otherwise indicated in the Contract Documents.
 - .1 Standing and Running Trim:
 - .1 Species For Transparent Finishing: Maple
 - .2 Species For Opaque Finishing: Birch
 - .2 Provide Premium Grade quality construction and finishing unless otherwise indicated in the Contract Documents.
 - .3 Casework Construction Type: Type A – Frameless construction with edge banded front edges.
 - .4 Interface Style: Style 1 – Flush Overlay unless otherwise indicated in the Contract Documents.
 - .5 Exposed Surfaces Core: Medium Density Fiberboard Core (MDF) unless otherwise indicated in the Contract Documents.
 - .6 Semi-Exposed and Concealed Surfaces Core: Medium Density Fiberboard Core (MDF) unless otherwise indicated in the Contract Documents.
 - .7 Edge Banding: Minimum 0.5 mm (0.02") thick ABS or PVC edgebanding, per AWS Section 10, Rule 4.4.26. Provide edgebanding for exposed (visible) and semi-exposed edges of the type specified in this Section.
 - .1 Case bodies: minimum 0.5 mm (0.0197") thick.
 - .2 Doors, drawer fronts, and false fronts: minimum 3 mm (1/8") thick.
 - .3 Pattern: wood grain to match door faces unless otherwise indicated in the Contract Documents.
 - .8 Facing: Plastic Laminate as specified in this Section.
 - .9 Plastic Laminates:
 - .1 Exposed Surfaces Finish: HGS for horizontal surfaces and VGS for vertical surfaces in accordance with AWS Section 4, Rule 4.2c.
 - .1 Finish: To be selected by Consultant from manufacturer's full range at a later date.
 - .2 Semi-Exposed Surfaces Finish: Plastic laminate; HGS for horizontal surfaces and VGS for vertical surfaces in accordance with AWS Section 4, Rule 4.2c.

- .1 Finish: Identical to exposed surfaces finish.
- .3 Concealed Surfaces Finish: Backing sheet; Provide BKV at vertical locations and BKH at horizontal locations; unless otherwise indicated in the Contract Documents.
- .2 Stainless Steel Countertops and Backsplashes: Refer to Section 12 35 71, Stainless Steel Casework.

2.3 FINISHES

- .1 Factory Finishing: Defer only final touch up, cleaning, and polishing until after installation. As far as practical, ensure casework is factory finished unless otherwise indicated or unavoidable:
 - .1 Apply finishes in accordance with AWS Section 5.
 - .2 Transparent Wood Finishing:
 - .1 Exposed parts: AWS System – 5, Varnish, Conversion or System – 7, Vinyl, Catalyzed.
 - .2 Semi-Exposed parts: AWS System – 5, Varnish, Conversion or System – 7, Vinyl, Catalyzed.
 - .3 Staining: Match the Consultant's sample.
 - .4 Sheen: Satin in accordance with ASTM D523.
 - .3 Opaque Wood Finishing:
 - .1 Exposed parts: AWS System – 5, Varnish, Conversion.
 - .2 Semi-Exposed parts: AWS Exposed parts: AWS System – 5, Varnish, Conversion.
 - .3 Staining: Match the Consultant's sample.
 - .4 Sheen: Satin in accordance with ASTM D523.
 - .4 Field Touch-Up: Ensure that field touch-up is performed by the installing trade and that the architectural woodwork manufacturer will perform factory finishing. Field touch-up includes filling and touch-up of exposed job-made nail and screw holes, refinishing of raw surface resulting from job fitting, repair of job-inflicted scratches and mars and final cleaning up of finished surfaces.

2.4 FABRICATION

- .1 Fabricate joints accurately fitted, coped where possible, and well glued up. Fabricate joints mitred to perfect fit and alignments carefully matched.
- .2 Fabricate finished woodwork in one piece where possible. Fabricate running members in the longest lengths obtainable.
- .3 Fabricate to conceal fastenings.
- .4 Provide plastic laminate Work in shop in accordance with ANSI/NEMA LD3. Provide backer sheets to panels to ensure balance.
- .5 Fabricate exposed gables to match the required exposed finishes.
- .6 Exposed wood construction:
 - .1 Fabricate joints carefully matched for grain and colour.
 - .2 Fabricate millwork with slow fed machines free from sticker and/or sander markings, with sections and moulding work cut accurately to profiles.
 - .3 Sandpaper woodwork, smooth removing burrs, feathers, sleeves, raised grain and sharp arises and leave exposed surfaces perfectly clean and smooth ready for finishing.

- .4 Provide edges noted to be solid, as minimum 6 mm (1/4") thick wood to match the exposed veneer to visible and semi-exposed edges, glued to the core prior to the application of face veneers. Provide plastic laminate or elastomeric edges to plastic laminate work visible or semi-visible edges.
- .7 Countertops:
 - .1 Fabricate and assemble countertops and side and back splashes in shop to profiles and lengths required.
 - .2 Fabricate cutouts for services penetrations as required.
 - .3 Verify governing dimensions before fabricating items which abut wall surfaces.
 - .4 Provide cutouts required and round internal corners, chamfer edges and seal exposed core.
 - .5 Provide sidesplashes at abutting ends of counters and at adjoining walls, unless otherwise indicated on the Drawings.
 - .6 Provide a 6 mm (1/4") drip groove approximately 13 mm (1/2") in from the underside edge.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: Verify actual Site dimensions and location of adjacent materials prior to commencing the Work. Notify the Consultant in writing of any conditions which would be detrimental to the installation.
- .2 Evaluation and Assessment: The commencement of work constitutes the Contractor's acceptance of previously completed work.

3.2 PREPARATION

- .1 Wood Surface Preparation for Finish:
 - .1 Verify and determine wood species, grain direction and structure, properties of finish, application method and exposure to elements. Check moisture content to avoid movement of wood caused by expansion and contraction due to changes in moisture content. Verify grain cut as it may interfere with adhesion of finish.
 - .1 Apply wood finishing Product in following order and as needed for specific appearance and application specified in this Section. Sanding sealer to control penetration of subsequent coats to create more uniform finish. Stain to colour wood and highlight grain for final finish. Filler to fill pores of wood and control penetration of subsequent coats. Apply filler across grain forcing it into pores followed with rubbing and sanding when dried. For staining requirements mix stain with filler before applying for uniform finish. Finish coats to Provide protection to wood.
 - .2 Woodwork for Clear Finish or Stain:
 - .1 Sand smooth all woodwork to be finished using 150 grit paper followed by a second sanding using 220 grit paper and clean surfaces free of dust using brush, compressed air or tack rags before applying first coat. Abrade surfaces with stiff brush to remove loose fibers and splinters. Fill nail holes, splits and scratches with non-shrinking filler tinted to match local grain condition after first coat is dry. Sand lightly between coats with No. 220 sandpaper and remove dust.

- .3 Wood Surface Preparation for Opaque Coating:
 - .1 Seal knots and sapwood in surfaces to receive paint with alcohol-based primer-sealer. Seal door edges. Sand smooth rough surfaces of woodwork to be finished using 150 grit paper followed by a second sanding using 220 grit paper. Sand in the direction of the grain. Clean surfaces free of dust before applying the first coat using brush, compressed air or tack rags. Fill nail holes, splits and scratches with non-shrinking filler after the first coat is dry. Remove salt deposits that may appear on wood surfaces treated with fire retarder.
 - .2 Prepare plywood surface by removing dirt and debris. Fill screw and nail holes or minor imperfections with recommended filler and sand properly to receive finish coating. Plywood requiring stained or painted finish shall be primed with top quality alkyd primer. Use only penetrating quality stain over plywood.
 - .3 Woodwork for Clear Finish or Stain: Sand smooth all woodwork to be finished using 150 grit paper followed by a second sanding using 220 grit paper and clean surfaces free of dust using brush, compressed air or tack rags before applying first coat. Abrade surfaces with stiff brush to remove loose fibers and splinters. Fill nail holes, splits and scratches with non-shrinking filler tinted to match local grain condition after first coat is dry. Sand lightly between coats with No. 220 sandpaper and remove dust.
 - .4 Remove salt deposits that may appear on wood surfaces treated with fire retarder.
 - .5 Ensure resilient flooring under millwork cabinets are provided prior to proceeding with the Work of this Section.

3.3 INSTALLATION

- .1 Install the Work of this Section in accordance with the corresponding Product section of the AWMAC AWS.
- .2 Grade: Install woodwork to comply with requirements for grade specified in this Section for fabrication of type of woodwork involved.
- .3 Assemble woodwork and complete fabrication at Site to comply with requirements for fabrication specified in this Section and to the extent that it was not completed in shop.
- .4 Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 3 mm in 2400 mm (1/8" in 8'-0").
- .5 Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- .6 Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated in the Contract Documents..
- .7 Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to Provide unencumbered operation. Complete installation of hardware and accessory items as indicated in the Contract Documents.
- .8 Install cabinets with no more than 3 mm in 2400 mm (1/8" in 8'-0") sag, bow, or other variation from a straight line.
- .9 Maintain veneer sequence matching of cabinets with transparent finish.
- .10 Fasten wall cabinets through back, near top and bottom, at ends and not more than 400 mm (16") o.c. with No. 10 wafer-head screws sized for 25 mm (1") penetration into wood framing, blocking, or hanging strips.

- .11 Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop. Install countertops with a maximum of 3 mm in 2400 mm (1/8" in 8'-0") sag, bow, or other variation from a straight line.
- .12 Align adjacent solid-surfacing-material countertops and form seams to comply with the manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean the entire surface.
- .13 Secure backsplashes to tops with concealed metal brackets at 400 mm (16") o.c. and to walls with adhesive.
- .14 Touch up finishing work specified in this Section after the installation of woodwork. Fill nail holes with matching filler where exposed.
- .15 Install solid polymer counter top surfaces at locations indicated on the Drawings in accordance with the manufacturer's recommendations to meet design requirements.
- .16 Provide the Work of this Section true and straight and securely fastened in place.
- .17 Mitre exposed corners and butt joints.
- .18 Provide plastic laminate countertops plumb and true, neatly scribed to adjoining surfaces.
- .19 Thoroughly fix and anchor the Work of this Section into position.
- .20 Mechanical and Electrical Fittings:
 - .1 Provide openings required to accommodate mechanical and electrical fittings as part of the Work of this Section and provide a core sealant to protect counter cores which are exposed to accommodate:
 - .1 mechanical services and fittings.
 - .2 washroom accessories.
 - .2 Locate and Install lenses where indicated on the Drawings. Carefully align lenses, shown in continuous lines, so that they appear as straight lines. Mount lenses perfectly level or plumb. Lenses shall fit tightly without showing space or light leak between frame and lenses. Remove improperly installed lenses and reinstall at no cost to the Owner.
 - .3 Mechanical and electrical fittings and services will be provided as part of the Work of Divisions 21, 22 23, 26, 27 and 28.
- .21 Installation of Architectural Woodwork Hardware:
 - .1 Install architectural woodwork hardware in accordance with AWMAC, AWS and manufacturer's requirements and templates. Adjust architectural woodwork hardware to Provide smooth operation and ensure clearances are maintained. Repair damage to adjacent surfaces resulting from failure to conform with this requirement.
 - .2 Provide lubricants required and use in a manner to ensure smooth function of hardware consistent with the manufacturer's recommendations.
 - .3 Verify that fastening components are tightened securely. Align screws, bolts and similar fastenings such that relationship of screw head indentations, similar surfaces and slots are perpendicular to the matching vertical or horizontal position when on the same surface. Do not burr or otherwise mar edges of surfaces of hardware components. Repair the defects caused by the Work of this Section to the satisfaction of the Consultant.
 - .4 Conform to keying requirements specified in this Section.

3.4 FINISHING

- .1 Prime unexposed surfaces including the backs of fitments against walls and underside of fitments.

- .2 Before priming, treat knots and sap streaks, with a coat of shellac and then prime with a wood primer.
- .3 Shop finish natural finished wood surfaces.

3.5 ADJUSTING AND CLEANING

- .1 Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork.
- .2 Adjust joinery for uniform appearance.
- .3 Clean, lubricate, and adjust hardware.
- .4 Clean woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION

PART 1 - GENERAL

1.1 PRICING

- .1 All costs associated with the work required by and associated with this Section shall be included as part of the Contract Price and in the price listed in item #1 of the Bid Form.

1.2 GENERAL INSTRUCTIONS

- .1 Read and conform to:
 - .1 the General Conditions and the Supplementary Conditions of the Contract;
 - .2 Division 1 requirements and documents referred to therein.

1.3 SUMMARY

- .1 Work Included: Provide joints sealants including but not limited to the following:
 - .1 Exterior joints in vertical surfaces and nontraffic horizontal surfaces
 - .2 Exterior joints horizontal traffic surfaces
 - .3 Interior joints vertical surfaces and horizontal nontraffic surfaces
- .2 Related Requirements: Specifications throughout the entirety of the Divisions of this Project are directly applicable to this Section, and this Section is directly applicable to them.

1.4 REFERENCES

- .1 Definitions:
 - .1 In the context of general purpose joint sealants, the following definitions apply in accordance with ASTM C920 for performance characteristics and are used accordingly in this Section:
 - .1 Sealant types:
 - .1 Type S: Single component sealant;
 - .2 Type M: Multi-component sealant;
 - .2 Rheological Properties:
 - .1 Grade P: Pourable or self-leveling sealant;
 - .2 Grade NS: Non-sag sealant
 - .3 Movement:
 - .1 Class 100/50: Sealant which can withstand an increase of at least 100% and a decrease of at least 50% of the joint width as measured at the time of applications
 - .2 Class 50: a sealant which can withstand an increase and a decrease of at least 50% of the joint width as measured at the time of applications
 - .3 Class 35: a sealant which can without an increase and a decrease of at least 35% of the joint width as measured at the time of applications
 - .4 Class 25: a sealant which can withstand an increase and a decrease of at least 25% of the joint width as measured at the time of applications

- .5 Class 12 ½: a sealant which can withstand an increase and a decrease of at least 12.5% of the joint width as measured at the time of applications
- .4 Usage:
 - .1 Use T: a sealant designed for use in joints in pedestrian and vehicular traffic areas such as walkways, plazas, decks and parking garages
 - .2 Use NT: a sealant designed for use in joints in nontraffic areas
 - .3 Use I: sealant designed for use in joints which are submerged continuously in a liquid
 - .4 Use M: a sealant that meets the requirements of ASTM C920 when tested on mortar specimens for adhesion and cohesion after cyclic movement requirements of ASTM C719 and adhesion in peel requirements of ASTM C794
 - .5 Use G: a sealant that meets the health, safety, emergency response hospital procedure and policy requirements of ASTM C920 and this Specification when tested on glass specimens or adhesion and cohesion after cyclic movement requirements of ASTM C719 and adhesion in peel requirements after ultraviolet exposure through glass of ASTM C794
 - .6 Use A: a sealant that meets the requirements of ASTM C920 when tested on aluminum specimens in accordance with for adhesion and cohesion after cyclic movement requirements of ASTM C719 and adhesion in peel requirements of ASTM C794
 - .7 Use O: a sealant that meets the requirements of ASTM C920 when tested on substrates other than the standard substrates in accordance with for adhesion and cohesion after cyclic movement requirements of ASTM C719 and adhesion in peel requirements of ASTM C794
- .2 Reference Standards: Latest published editions of reference standards listed in this Section in effect as of the closing date and time of the Request for Tenders for the Contract, including any amendments adopted, are applicable unless otherwise indicated.

1.5 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings:
 - .1 Prior to starting work of this Section, convene a pre-installation meeting at the Project site to review the Project requirements and site conditions with pertinent parties. Conform to requirements of Section 01 30 00.

1.6 SUBMITTALS

- .1 Product Data: Submit manufacturer's literature and data sheets for each type of material provided under this Section for the Project in accordance with requirements of Section 01 30 00. Ensure data sheets provide required information including detailed instructions for installing as well as maintaining, preserving and keeping materials in clean and safe conditions. Provide adequate warning of maintenance practices or cleaning agents detrimental to specified materials.
- .2 Material Safety Data Sheets: Submit MSDS for inclusion in operation and maintenance manual without limitations for adhesives, sealants and any other material later designated by Consultant.
- .3 Compatibility Testing Report: Prior to Supply or installation, test exterior sealant materials for compatibility with joint substrates. Test for staining and adhesion of materials including substrates treated with sealers, curing compounds and water repellants and materials which

may contact sealant. Submit written report of test results to the Consultant in accordance with Section 01 30 00.

.4 Colours:

.1 Colour Hierarchy: Submit sealant colours for acceptance in accordance with the following general colour hierarchy. Between 2 dissimilar materials, colour the sealant to match the material with the higher relative position on the colour hierarchy scale (highest is at ".1"):

- .1 Concrete.
- .2 Masonry.
- .3 Metal extrusions.
- .4 Metal (formed).

.2 For fully concealed joints, Provide the manufacturer's standard color of sealant which has the best overall performance characteristics for the application shown.

.5 Samples: Submit samples in accordance with Section 01 30 00. Provide cured, colour samples of the manufacturer's standard range of colours in each type of sealant and caulking compound for colour selection by the Consultant. Submit samples of primer, bond breaker tape and joint backing material, if requested.

1.7 QUALITY ASSURANCE

.1 Installer Qualifications: Provide work of this Section executed by competent installers who have a membership in good standing in the Sealant and Waterproofing Association and with a minimum of 5 years' experience in the application of the Products, systems and assemblies specified herein and with the approval and training of the Product manufacturers. Include lists of completed projects with the projects' names, the names of the consultants on the projects and contact persons.

.2 Testing Agency Qualifications: Retain an independent testing agency qualified in accordance with ASTM C1021 to conduct the testing indicated, as documented according to the sealant manufacturer's recommendations. Ensure materials are verified for suitability in accordance with ASTM C719 and ASTM C661.

.3 Preconstruction Testing:

.1 Test elastomeric joint sealants for compliance with requirements of ASTM C920 and, where applicable, to other standard test methods.

.2 Test elastomeric joint sealants for compliance with requirements of ASTM C920 for adhesion and cohesion under cyclic movement, adhesion-in peel and indentation hardness.

.3 Test other joint sealants for compliance with the requirements indicated in this Section by referencing standard specifications and test methods.

.4 Prior to commencement of sealing, arrange for the sealant manufacturer's technical representative to visit the Place of the Work and inspect the surfaces and joints to be sealed.

.5 Test for compatibility of sealant and accessory Products with joint substrates. Test results and written recommendations for primers and substrate preparation required for proper adhesion. For materials failing tests, obtain the joint sealant manufacturer's written instructions for corrective measures, including the use of specialty formulated primers.

.4 Single Source Responsibility: Ensure primary materials provided in this Section are obtained from 1 source by a single manufacturer and secondary materials are obtained from sources recommended by primary materials manufacturers.

.5 Mock-ups:

- .1 Conform to requirements of Section 01 40 00. At the Site, in area(s) designated by the Consultant, erect sample panels 1 m (39") long for determined type(s) of sealant joint design, showing location, size, shape and depth of joint complete with backup materials, primer, caulking and sealant, bond, colour and quality of installation work.
- .2 If requested, conduct a field test for joints designated. Construct additional mock-ups if required to obtain approval. Do no sealant work until mock-ups have been approved. Approved mock-ups become the standard of comparison for sealant and caulking work on site and may become part of the finished installation if left undisturbed at the time of Substantial Performance of The Work.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Deliver caulking and sealant materials to the Site in original, unopened containers with manufacturers' labels and seals intact. Labels shall identify manufacturer's name, brand name of Product, grade and type, application directions and shelf life or expiry date of Product.
- .2 Handle and store materials in accordance with manufacturer's printed directions. Store flammable materials in safe, approved containers to eliminate fire hazards.
- .3 Do not use caulking and sealant materials that have been stored for period of time exceeding maximum recommended shelf life of materials.

1.9 PROJECT CONDITIONS

- .1 Environmental Requirements: Do not apply any sealant under adverse weather conditions, when joints to be sealed are damp, wet or frozen or when at ambient temperatures below 5 deg C (40 deg F). Maintain minimum temperature of application during application and for 8 hours after application. Consult the manufacturer for specific instructions before proceeding; obtain the Consultant's approval.
- .2 Do not proceed with installation of joint sealants where joint widths are less than those allowed by the joint sealant manufacturer for applications indicated, and until contaminants capable of interfering with adhesion are removed from joint substrates.

1.10 WARRANTY

- .1 The Contractor warrants the work of this Section for period of 5 years from Substantial Performance of the Work against defects and deficiencies in accordance with General Conditions of the Contract. Promptly correct defects or deficiencies which become apparent within this warranty period, to the satisfaction of the Consultant and at no expense to the Owner. Defects include but are not limited to: cracking, crumbling, melting, shrinkage, sag, adhesion or cohesion failure, reversion, air and moisture leakage, marbling or streaking due to improper mixing, discolouration due to dirt pick-up during curing and staining of adjacent materials.

1.11 MANUFACTURER'S GUARANTEE (EXTERIOR SEALANTS)

- .1 Provide sealant manufacturer's non-stain guarantee naming the Owner as beneficiary and covering defects and deficiencies and weather tightness of complete membrane and flashings for 20 years from Substantial Performance of the Work.
- .2 Provide a guarantee covering the materials described in this Section. The guarantee shall include the furnishing, repair and replacement of such materials at the manufacturer's expense

and to the extent required for the work of this Section which does not comply with performance and other requirements specified herein.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 Products of following manufacturers are acceptable subject to conformance to requirements of Drawings, schedules and Specifications:
 - .1 BASF Inc.
 - .2 CPD Construction Products;
 - .3 Dow Corning
 - .4 Euclid Chemical Canada Ltd.
 - .5 Momentive Performance Materials;
 - .6 Hilti (Canada) Limited
 - .7 Pecora Corporation
 - .8 Sika Canada Inc.
 - .9 Tremco Canada
 - .10 W. R. Meadows
 - .11 or Equivalent to the above.

2.2 DESCRIPTION

- .1 Regulatory Requirements:
 - .1 Ensure sealants comply with ~~LEED and~~ requirements of Authorities Having Jurisdiction with regards VOC emission.
- .2 Performance Requirements:
 - .1 Provide exterior and interior elastomeric joint sealants establishing and maintaining water tight, water resistant and air tight continuous joint seals without staining or deteriorating joint substrates.
 - .2 Ensure elastomeric sealants provided comply with ASTM C920 and other standards specified herein for type, grade, class and uses.
 - .3 Provide Products with capability, when tested for adhesion and cohesion under maximum cyclic movement in accordance with ASTM C719, to withstand required percentage change in joint width existing at the time of installation and remain in compliance with other requirements of ASTM C920 for uses indicated.
 - .4 Provide elastomeric sealants that are non-staining and have undergone testing in accordance with ASTM C1248 for joint substrates indicated for the Project.

2.1 EXTERIOR JOINT SEALANTS

- .1 Single component, nonsag, neutral curing silicone sealant, ASTM C920, Type S, Grade NS, Class 100/50 or Class 50 as required for applications and joint design, for Use NT or nonstaining silicone sealant according to ASTM C 1248.

- .1 Exterior joints in vertical surfaces and horizontal non-traffic surfaces as follows:
 - .1 Construction joints in cast-in-place concrete.
 - .2 Control and expansion joints in unit masonry.
 - .3 Joints between different materials listed above.
 - .4 Perimeter joints between materials listed above and frames of doors, windows and louvers.
 - .5 Other joints as indicated on Drawings and Schedules.
- .2 Acceptable Products:
 - .1 "Dowsil 790" or "Dowsil 795" or "Dowsil CCS" by Dow Chemical of Canada ULC
 - .2 "Spectrem 1" or "Spectrem 2" by Tremco Incorporated
 - .3 "Sikasil WS-290" or "Sikasil WS-295" by Sika Canada Inc.
 - .4 "Silpruf SCS2000" or "Silpruf LM SCS2700" by GE Silicones (Momentive Performance Materials)
 - .5 "890NST" or "864NST" by Pecora Corporation
 - .6 Approved equivalent.
- .2 Single component, nonsag, low dirt pick-up, non-staining, neutral curing silicone sealant, ASTM C920, Type S, Grade NS, Class 100/50 or Class 50 as required for applications and joint design, for Use NT.
 - .1 Exterior joints in vertical surfaces and horizontal non-traffic surfaces as follows:
 - .1 Joints between plant-precast architectural concrete units.
 - .2 Joints in stone masonry and cladding.
 - .3 Joints in metal panel substrates.
 - .4 Joints between different materials listed above.
 - .5 Other joints as indicated on Drawings and Schedules.
 - .2 Acceptable Products:
 - .1 "Spectrem 3" or "Spectrem 4 TS" by Tremco Incorporated
 - .2 "Dowsil 756 SMS" by Dow Chemical of Canada ULC
 - .3 "Silpruf NB SCS9000" by GE Silicones (Momentive Performance Materials)
 - .4 "Sikasil WS-290" or "Sikasil WS-295" by Sika Canada Inc
 - .5 Approved equivalent.
- .3 Single-Component, Nonsag, Traffic-Grade, Neutral-Curing Silicone Joint Sealant, ASTM C920, Type S, Grade NS, Class 100/50, for Use T.
 - .1 Exterior joints in horizontal traffic surfaces as follows:
 - .1 Control and expansion joints in brick pavers.
 - .2 Isolation and contraction joints in cast-in-place concrete slabs.
 - .3 Joints between plant-precast architectural concrete paving units.
 - .4 Joints in stone paving units, including steps.
 - .5 Tile control and expansion joints.
 - .6 Joints between different materials listed above.
 - .7 Other joints as indicated on Drawings and Schedules.
 - .2 Acceptable Products:
 - .1 "Dowsil 790" or "Dowsil NS Parking Structure Sealant" by Dow Chemical of Canada ULC
 - .2 "Spectrem 800/900SL" by Tremco Incorporated
 - .3 "Sikasil -728 SL" or "Sikasil -728 NS" by Sika Canada Inc.
 - .4 "301 NS" or "311 NS" by Pecora Corporation

- .5 Approved equivalent.
- .4 Single-Component or Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant, ASTM C920, Type S or Type M, Grade P, Class 25 or Class 50 as required by joint design, for Use T.
 - .1 Exterior joints in horizontal traffic surfaces subject to water immersion as follows:
 - .1 Joints in pedestrian plazas.
 - .2 Joints in swimming pool decks.
 - .3 Other joints as indicated on Drawings and Schedules.
 - .2 Acceptable Products:
 - .1 "TH901" or "Vulkem 45 SSL" by Tremco Incorporated
 - .2 "MasterSeal SL 1 or MasterSeal SL 2" by Master Builders Solutions
 - .3 "Urexpan NR-201" by Pecora Corporation
 - .4 "Sikaflex - 1CSL" or "Sikaflex 2C SL" by Sika Canada Inc.
 - .5 Approved equivalent.

2.2 INTERIOR JOINT SEALANTS

- .1 Single component, nonsag, neutral curing silicone or urethane sealant, ASTM C920, Type S or Type M, Grade NS, Class 50, Class 35 or Class 25 as required for applications and joint design, for Use NT.
 - .1 Interior joints in vertical surfaces and horizontal nontraffic surfaces as follows:
 - .1 Control and expansion joints on exposed interior surfaces of exterior walls.
 - .2 Perimeter joints of exterior openings.
 - .3 Tile control and expansion joints.
 - .4 Vertical joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
 - .5 Joints on underside of plant-precast structural concrete beams and planks.
 - .6 Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.
 - .7 Other joints as indicated on Drawings and Schedules.
 - .2 Acceptable Products:
 - .1 "Dowsil 791" or "Dowsil 795" or "Dowsil CWS" by Dow Chemical of Canada ULC
 - .2 "Spectrem 2" or "Spectrem 3" or "Dymonic" or "Dymonic FC" by Tremco Incorporated
 - .3 "SilPruf LM SCS2700" by GE Silicones (Momentive Performance Materials)
 - .4 "890NST" or "890FTS" or "864NST" or "PCS" or "DynaTrol I-XL" or "DynaTrol II" by Pecora Corporation
 - .5 "SikaSil WS-295" by Sika Canada Inc.
 - .6 Approved equivalent.
- .2 Mildew-Resistant, Single-Component, Nonsag, Silicone Joint Sealant, ASTM C920, Type S, Grade NS, Class 25, for Use NT
 - .1 Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces as follows:
 - .1 Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - .2 Tile control and expansion joints.
 - .3 Other joints as indicated on Drawings and Schedules.
 - .2 Acceptable Products: Mildew-Resistant, Single-Component, Acid-Curing or Neutral Curing Silicone Joint Sealant, ASTM C920, Type S, Grade NS, Class 25, for Use NT.

- .1 "Dowsil 786 Mildew Resistant" or "Dowsil Tub/Ceramic/Tile" by Dow Corning Corporation
 - .2 "Silicones; Sanitary SCS1700" by GE Silicones (Momentive Performance Materials)
 - .3 "Tremsil 200 Sanitary" by Tremco Incorporated
 - .4 "Sikasil GP/GP HT" by Sika Canada Inc.
 - .5 "898 NST" by Pecora Corporation
- .3 Nonsag, paintable, nonstaining latex complying with ASTM C834 or butyl rubber sealant complying with ASTM C1311.
 - .1 Surface Burning Characteristics: Flame spread, and smoke developed indexes not greater than 25 and 450, respectively.
 - .2 Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces as follows:
 - .1 Acoustical joints at top and bottom of gypsum board partitions; at top of masonry walls and through non fire-rated penetrations in gypsum and masonry walls.
 - .2 Other joints as indicated on Drawings and Schedules.
 - .3 Acceptable Products:
 - .1 "AC-20 FTR" or "AIS-919" by Pecora Corporation
 - .2 "SHEETROCK Acoustical Sealant" by CGC Inc.
 - .3 "QuietZone Acoustic Sealant" by Owens-Corning Canada Inc.
 - .4 "Tremco Acoustical Sealant" by Tremco Ltd.
 - .5 "QuietSeal" or "QuietSeal 350" by Serious Materials.
 - .6 "CP506 – Smoke and Acoustic Sealant" by Hilti
 - .7 "RCS20" by GE Silicones (Momentive Performance Materials)
 - .8 "MasterSeal NP520" by Master Builders Solutions
- .4 Single-Component or Multicomponent, Traffic-Grade, Silicone or Urethane Joint Sealant, ASTM C920, Type S or Type M, Class 25 or Class 50 as required by joint design, for Use T
 - .1 Interior traffic joints as follows:
 - .1 Isolation joints in cast-in-place concrete slabs. Refer to Section 03 35 00 for filling of contraction joints.
 - .2 Acceptable Products:
 - .1 "Dowsil 790" by Dow Corning Corporation
 - .2 "301 NS" or "311 NS" "300 SL" or "310 SL" by Pecora Corporation
 - .3 "Spectrem 800/900SL" by Tremco Incorporated
 - .4 "Sikaflex - 1CSL or Sikaflex 2C SL" by Sika Canada Inc.
 - .5 "MasterSeal SL1" or "MasterSeal SL2" by Master Builders Solutions
- .5 Single-Component or Multicomponent, Traffic-Grade, Silicone or Urethane Joint Sealant, ASTM C920, Type S or Type M, Class 25 or Class 50 as required by joint design, for Use T
 - .1 Interior traffic joints as follows:
 - .1 Control and expansion joints in stone flooring.
 - .2 Control and expansion joints in tile flooring.
 - .3 Other joints as indicated on Drawings and Schedules.
 - .2 Acceptable Products: As recommended by flooring manufacturer and conforming to TTMAC guidelines.
- .6 Single-Component Silicone complying with ASTM C920, Grade NS, Class 25 or butyl rubber sealant complying with ASTM C1311.
 - .1 Interior traffic joints as follows:

- .1 Concealed sealants for bedding thresholds and sills.
- .2 Acceptable Products:
 - .1 "Dowsil 758" by Dow Corning Corporation
 - .2 "Tremco Butyl Sealant" by Tremco Incorporated
 - .3 "BC-158" or "BA-98" by Pecora Corporation
 - .4 "MasterSeal NP1" by Master Builders Solutions
- .7 Silicone glazing sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.
 - .1 Glazing applications as follows:
 - .1 Non-structural sealing for butt-glazing in interior applications and other non-moving glazing joints.
 - .2 Acceptable Products:
 - .1 "Dowsil 799" or "Dowsil Glazing" by Dow Chemical of Canada ULC
 - .2 "UltraGlaze SSG4000" or "UltraGlaze SSG4000AC" by GE Silicones (Momentive Performance Materials)
 - .3 "Tremsil 200" by Tremco Incorporated
 - .4 "Sikasil - N Plus" by Sika Canada Inc.
- .8 Single-Component, Nonsag, Urethane Tamper-resistant Security Joint Sealant, ASTM C920, Type S or Type M, Grade NS, Class 12.5, for Use NT, Shore A hardness 40 +/- 5 in accordance with ASTM C661.
 - .1 Interior tamper-resistant security joints as follows:
 - .1 Moving (e.g. perimeters of exterior openings) and non-moving (e.g. fixture joints) in public and supervised locations such as [day rooms,] [exercise rooms,] [cafeterias,] and similar locations.
 - .2 Acceptable Products:
 - .1 "Pecora Dynaflex™ SC" by Pecora Corporation
 - .2 "Masterseal CR195" by Master Builders Solutions.
 - .3 "DOWSIL™ 995 Silicone Structural Sealant" by Dow Chemical of Canada ULC
 - .4 "Sikaflex 11FC" or "Sika Construction Adhesive"

2.3 COMPONENTS

- .1 Joint Backing: Preformed, compressible, resilient, non-waxing, non-extruding, non-staining strips of closed cell polyethylene or urethane foam, compatible with joint substrates and are approved by the sealant manufacturer based on field experience and laboratory test. Sizes and shapes to suit various conditions, diameter 25% greater than joint width. Backing shall be compatible with sealant, primer and substrate.
- .2 Bond Breaker Tape: As recommended by the sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.
- .3 Joint Primer: Non-staining, suitable for substrate surfaces, compatible with joint forming materials and as recommended by the sealant manufacturer for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

- .4 Masking Tape: Provide non-staining, non-absorbent tapes and sheets which effectively mask sealant without leaving an adhesive residue compatible with joint sealants and surfaces adjacent to joints.
- .5 Cleaning Material: Non-corrosive, non-staining, solvent type, xylol, methyl-ethyl-ketone (MEK), toluol, isopropyl alcohol (IPA) or as recommended by the sealant manufacturer and acceptable to the material or finish manufacturers for surfaces adjacent to sealed areas free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way and formulated to promote optimum adhesion of sealants with joint substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Examine joints for compliance with requirements for joint configuration, installation tolerances and other conditions affecting joint sealant performance. Ensure joints are suitable to accept and receive sealants.
- .2 Verify that joint surfaces are clean, sound, free of defects and that dimensions are within the sealant manufacturer's size requirements.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected. Commencement of work implies acceptance of surfaces and conditions.
- .4 Do not apply sealant to masonry until mortar has cured.
- .5 Before any sealing work is commenced, test materials for indications of staining or poor adhesion.
- .6 Notify the Consultant in writing of any conditions which would be detrimental to the installation. Commencement of work implies acceptance of previously completed work.

3.2 PREPARATION

- .1 Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.
- .2 Clean joints and spaces which are to be sealed and ensure they are dry and free of dust, loose mortar, oil, grease, oxidation, coatings, form release agents, sealers and other foreign material.
- .3 Clean porous surfaces such as concrete, masonry or stone by wire brushing, grinding or blast cleaning, mechanical abrading or combination of these methods as required to obtain clean and sound surfaces.
- .4 Remove laitance by grinding or mechanical abrading.
- .5 Remove oils by sandblast cleaning.
- .6 Remove loose particles present or resulting from grinding, abrading or sandblast cleaning by thorough brushing.
- .7 Clean ferrous metals of rust, mill scale and foreign materials by wire brushing, grinding or sanding.
- .8 Wipe non-porous surfaces such as metal and glass to be sealed, except pre-coated metals, with cellulose sponges or clean rags soaked with solvent recommended by manufacturer and

wipe dry with clean cloth. Where joints are to be sealed with silicone based sealants clean joint with methyl-ethyl-ketone (MEK) or xylol. Do not allow solvent to air-dry without wiping. Clean pre-coated metals with solutions or compounds which will not injure finish and which are compatible with joint primer and sealant. Check ferrous metal surfaces are painted before applying sealant.

- .9 Examine joint sizes and where depth of joint exceed required depth of sealant correct to achieve proper following width/depth ratio:
 - .1 Maintain 2:1 width/depth ratio: minimum joint size to be 6 mm (1/4") x 6 mm (1/4"), maximum depth of sealant to be 13 mm (1/2").
- .10 Install joint backing material to achieve correct, uniform joint profile and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
- .11 Do not leave gap between ends of sealant backing; do not stretch, twist, puncture, or tear sealant backings; remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- .12 Where joint design or depth of joint prevents use of joint backing material, apply bond breaker tape to prevent 3-sided adhesion.
- .13 Do not stretch, twist, puncture or tear joint backing. Butt joint backing at intersections. Install bond breaker tape at back of joint where joint backing is not required or cannot be installed.
- .14 On horizontal traffic surfaces, support joint filler against vertical movement which might result from traffic loads, including foot traffic.
- .15 Where surfaces adjacent to joints are likely to become coated with sealant during application, mask them prior to priming and sealing.
- .16 Do not exceed shelf life and pot life of materials and installation times, as stated by the manufacturer.
- .17 Be familiar with work life of sealant to be used. Do not mix multiple component materials until required for use.
- .18 Use materials as received from the manufacturer, without additions, deletions and adulterations of materials.
- .19 Mix multiple component sealants and bulks sealants using mechanical mixer capable of mixing without mixing air into material, in accordance with the manufacturer's directions and recommendations. Continue mixing until material is homogeneously blended, uniform in colour and free from streaks of unmixed material. Install compound prior to start of hardening or curing cycle.
- .20 Seal joints in surfaces to be painted before surfaces are painted. Where surfaces to be sealed are prime painted in shop before sealing, check to make sure the prime paint is compatible with primer and sealant. If they are incompatible, inform the Consultant and change primer and sealant to compatible types approved by the Consultant.
- .21 Where irregular surface or sensitive joint border exists, apply masking tape at edge of joint to ensure joint neatness and protection.
- .22 Prime sides of joints for type of surface being sealed prior to application of joint backing, bond breaker or sealant as recommended by sealant manufacturer.

3.3 APPLICATION

- .1 Apply in accordance with the manufacturer's directions and recommendations unless more stringent requirements apply.

- .2 Apply sealant by proven techniques using hand operated guns or pressure equipment fitted with suitable nozzle size and equipment approved by sealant manufacturer.
- .3 Force sealant into joint and against sides of joints to obtain uniform adhesion. Use sufficient pressure to completely fill all voids in joint regardless of variation in joint widths and to proper joint depth as prepared. Ensure full firm contact with interfaces of joint. Superficial pointing with skin bead is not acceptable.
- .4 Finish face of compound to form smooth, uniform beads. At recesses in angular surfaces, finish compound with flat face, flush with face of materials at each side. At recesses in flush surfaces, finish compound with concave face flush with face of materials at each side.
- .5 Compound may be tooled, provided such tooling does not damage seal or tear compound. Avoid pulling of sealant from sides.
- .6 Tool surfaces as soon as possible after sealant application or before any skin formation has occurred, particularly when using silicone sealants.
- .7 Ensure joint surfaces are straight, neatly finished, free from ridges, wrinkles, sags, dirt, stains, air pockets and embedded foreign matter or other defacement and be uniform in colour, free from marbling and/or colour streaking due to improper mixing or use of out of shelf life Products.
- .8 Do not use solvent curing sealants indoors.

3.4 SEALANT LOCATIONS

- .1 Use 1 of the sealants specified for each type in locations indicated in the sealant schedules below. Ensure the sealant chosen for each location is recommended by the manufacturer for use for the conditions encountered.
- .2 Joint designation and application in the following tables and the fact that Drawings do not show all locations to be sealed does not limit the Contractor's responsibility under this Section to seal all locations (except those indicated in other Sections of work) required to create and ensure continuous enclosure.
- .3 Firestopping and Smoke Seal: Sealants part of firestopping systems and smoke seals provided within fire rated assemblies shall be part of the work of Section 07 84 10 and shall be carried out under supervision of those performing the work under this Section.

3.5 FIELD QUALITY CONTROL

- .1 An independent inspection and testing company may be appointed and paid for by the Owner to carry out inspection and testing as directed by the Consultant.
- .2 Inspect joints for complete fill, for absence of voids and for joint configuration complying with requirements specified herein. Record results in a manner acceptable to the Consultant.
- .3 Tests may include sampling of installed Product where adhesion, cohesion or reversion failure is suspected.
- .4 Where work or materials fail to meet requirements specified herein, as indicated by the test results, pay the costs of additional inspection and testing required for new replacement work or materials.
- .5 Manufacturer's Services:
 - .1 Confirm in writing that the manufacturer's representative will be on site throughout the construction period work to inspect the application of sealant and surface preparation.
 - .2 Consult with the manufacturer's technical representative about the following items:

- .1 weather conditions under which work will be done.
- .2 anticipated frequency of joint movement.
- .3 shape factor of the joint.
- .4 durometer hardness, slump and curing characteristics of materials specified.
- .5 joint characteristics as built.
- .6 installation procedures to be adopted.
- .7 mixing procedures to be adopted.
- .8 conditions under which the Work will be done, in order that any alternative recommendations may be made should adverse conditions exist.

3.6 CLEANING

- .1 Immediately clean adjacent surfaces which have been soiled and leave work in neat, clean condition. Remove excess materials, compounds smears or other soiling resulting from application of sealants. Use recommended cleaners and solvents. Leave finished work in neat, clean condition with no evidence of spillovers onto adjacent surfaces.

3.7 PROTECTION

- .1 Provide approved, non-staining means of protection for completed joint sealant installations where required to protect work from mechanical, thermal, chemical and other damage by construction operations and traffic.
- .2 Maintain protection securely in place until completion of Work. Remove protection when so directed by the Consultant.
- .3 Repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION

PART 1 - GENERAL

1.1 PRICING

- .1 All costs associated with the work required by and associated with this Section shall be included as part of the Contract Price and in the price listed in item #1 of the Bid Form.

1.2 GENERAL INSTRUCTIONS

- .1 Read and conform to:
 - .1 The General Conditions and Supplementary Conditions of the Contract as amended in the Contract Documents.
 - .2 Division 01 requirements and any additional documents referred to therein.

1.3 SUMMARY

- .1 Work Included: Provide unit skylights including but not limited to following:
 - .1 Unit skylights and associated glazing.
 - .2 Auxiliary materials required for a complete installation.
- .2 Related Requirements: Specifications throughout the entirety of Divisions of this Project are directly applicable to this Section, and this Section is directly applicable to them.

1.4 REFERENCES

- .1 Reference Standards: Unless otherwise stipulated by a specific publication date in this Section or the Ontario Building Code, the latest published editions of reference standards in force as of the Bid Closing Deadline for the Project, including adopted amendments, are applicable.

1.5 ADMINISTRATIVE REQUIREMENTS

- .1 Sequencing: Coordinate installation with other related Sections.
- .2 Pre-Installation Meetings:
 - .1 Prior to starting work of this Section, convene a pre-installation meeting at Project site to review Project requirements and site conditions with pertinent parties. Conform to requirements of Section 01 31 00.
 - .2 Pre-construction Site Meeting:
 - .1 Prior to start of work, arrange for Project site meeting of parties associated with work of this Section, including non-exhaustively Subcontractor performing work of trade involved, testing company's representative and Contractor's consultants of applicable discipline. Consultant may attend.
 - .2 Review Contract Documents to permit compliance with intent of this Section for work included under this trade, and ensure complete understanding of requirements and responsibilities relative to:
 - .1 work included,
 - .2 materials to be used,
 - .3 storage and handling of materials,

- .4 installation of materials,
 - .5 sequence and quality control,
 - .6 Project staffing,
 - .7 restrictions on areas of work and other matters affecting construction.
- .3 In particular ensure Division 3 requirements for concrete are compatible with requirements of this Section. Ensure following meet acceptable criteria to ensure proper performance floor covering work:
- .1 floor flatness and floor levelness requirements for flooring installation and their acceptability by flooring manufacturer;
 - .2 surface texture of finished floor required for flooring installation;
 - .3 acceptable approaches to remediation of high moisture and high pH floors;
 - .4 adhesive application and floor covering installation. Scheduling:
- .4 Prior to commencing work of this Section arrange for the manufacturer's technical representative to review with Contractor and Consultant, procedures to be adopted and conditions under which work is to be performed. Inspect surfaces to determine adequacy of existing and proposed conditions.
- .5 Cooperate fully with other Subcontractors on The Work and promptly proceed with work of this Section as rapidly as job conditions permit.
- .6 Supply items to be built-in in ample time to be incorporated into work of other Subcontractors, together with measurements and other information required for location thereof.
- .7 Ensure work which may create dust does not proceed during work related to painting and final finishing.

1.6 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's literature, data sheets for each type of material provided under this Section for Project.
 - .2 Data sheets shall provide all required information. Submit 3 copies of detailed instructions for maintaining, preserving and keeping materials in clean and safe conditions and give adequate warning of maintenance practices or materials detrimental to specified materials. Submit manufacturer's installation instructions.
- .2 Safety Data Sheets (SDS): Submit SDS for inclusion in Operation and Maintenance Manual specified in Section 01 78 00, for adhesives, sealants and any other material designated by Consultant.
- .3 Shop Drawings: Submit Shop Drawings indicating material layouts, details of construction, connections, and relationship with adjacent construction. As a minimum indicate following:
 - .1 Include plans, elevations, sections and details as applicable.
 - .2 Air Barrier Interface Detailing: Indicate details of air barrier, waterproofing and vapour retarder interface materials, accessories, fastening, seals, and relationship to The Work as necessary to coordinate The Work with other building trades.

- .3 Manufacturer's literature must clearly indicate intended plane of primary air and water resistance for skylight system.
- .4 Indicate field-measured dimensions on Shop Drawings.
- .5 Delegated Design Submittals:
 - .1 Engineering design completion of unit skylights work is delegated to Contractor based on structural design criteria indicated in Contract Documents.
 - .2 Submit Shop Drawings for work of this Section that bear the stamp of a Professional Engineer registered in Province of the Work.
 - .3 Submit copy of structural calculations upon request by Consultant.
- .6 Samples: Submit one 300 mm (12 inch) length of each type of skylight frame with portion of acrylic ~~dome~~pyramid.
- .7 Embodied Carbon / Environmental Product Declarations (EPDs): When available, submit product-specific or industry-wide regional (i.e., North American) EPDs conforming to ISO 14025 or other recognized environmental Product declaration framework meeting following criteria:
 - .1 EPD Scope: must cover Cradle-to-Gate (A1 to A3) as a minimum.
 - .2 EPD Impact Categories: must report Global Warming Potential (GWP) in form of unit of kgCO₂e/declared unit as a minimum.
 - .3 Product Options: Give preference to Products with compliant documentation when choice is at Contractor's option.
- .8 Material Ingredient Disclosure: When available, submit documentation disclosing chemical inventory of materials to at least 0.1% (1000ppm) meeting following criteria:
 - .1 Standard: Health Product Declaration (HPD) Open Standard, Cradle to Cradle v2 (Basic level) or Cradle to Cradle v3 (Bronze level), International Living Future Institute (ILFI) Declare, or other approved material ingredient declaration framework.
 - .2 Product Options: Give preference to Products with compliant documentation when choice is at Contractor's option.
- .9 Low-Emitting Materials: For applicable Products specified or used for activities of this Section (i.e., site-applied coatings, adhesives, and sealants), submit certifications from third-party organizations indicating compliance with following:
 - .1 VOC Emissions: California Department of Public Health (CDPH) Standard Method v1.2–2017, using applicable exposure scenario.
 - .2 VOC Content: SCAQMD Rule 1113 (for paints and coatings) and SCAQMD Rule 1168 (for adhesives and sealants).

1.7 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Manufacturers: Provide Products for Work of this Section by manufacturer with minimum 10 years' experience in the manufacture of such materials.
 - .2 Installers: Provide work of this Section executed by competent installers with minimum 5 years' experience in the application of Products, systems and assemblies specified and with approval and training of the Product manufacturers.

- .2 Licensed Professionals: Employ a professional structural engineer registered in the province of Ontario, carrying minimum of \$2,000,000.00 professional liability insurance to:
 - .1 design the components of the work of this Section requiring structural performance and their attachments to building's structure,
 - .2 be responsible for full assemblies and connections,
 - .3 be responsible for determining sizes, yield strengths, gauge thicknesses and joint spacing to allow thermal movement and loading of components in accordance with applicable codes and regulations,
 - .4 be responsible for production and review of Shop Drawings,
 - .5 inspect the work of this Section during fabrication and erection,
 - .6 stamp and sign each shop drawing,
 - .7 Provide site administration and inspection of this part of the Work.
 - .8 Submit certificate validating seismic assessment and field review of this part of the Work.
- .3 Mock-ups:
 - .1 Provide Mock-ups in locations designated by Consultant and as required to demonstrate quality of workmanship.
 - .2 Maintain Mock-ups during construction in an undisturbed condition as a standard for judging completed work.
- .4 Single Source Responsibility: Ensure primary materials provided in this Section are obtained from 1 source by a single manufacturer and secondary materials are obtained from sources recommended by primary materials manufacturers.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- .2 Sequence deliveries to avoid delays and minimize on site storage.
- .3 Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.
- .4 Wrap protective heavy paper or apply strippable sprayed plastic to prevent any marring, scratching or damage to plastic and metal during handling and after installation.

1.9 WARRANTY

- .1 Warrant work of this Section for period of 5 years from Substantial Performance of the Work against defects and/or deficiencies in accordance with General Conditions of the Contract. Promptly correct any defects or deficiencies which become apparent within warranty period, to satisfaction of Consultant and at no expense to Owner. Defects include but are not limited to; buckling, opening of seams, bond failure and extensive colour fading.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 Products of following manufacturers may be acceptable subject to conformance to requirements of Drawings, Schedules and Specifications:

- .1 A. I. A. Industries, Inc.
- .2 Arc-O-Lite Skylights;
- .3 Artistic Skylights;
- .4 Kingspan / CPI International;
- .5 Velux International
- .2 Comparable Products from manufacturers listed herein offering functionally and aesthetically equivalent products in Consultant's opinion, and subject to Consultant's review, will be considered provided they meet the requirements of this Specification.

2.2 REGULATORY REQUIREMENTS

- .1 Conform to OBC requirements to support snow load and wind load for location of project as minimum comply with loads specified herein.

2.3 PERFORMANCE / DESIGN CRITERIA

- .1 Comply with AAMA/WDMA/CSA101/I.S.2/A440 (NAFS) or NFRC 400.
- .2 Provision For Thermal Movement:
 - .1 Unit skylights must be designed to accommodate expansion and contraction of component materials caused by exterior metal surface temperatures ranging from 35 deg C (-31 deg F) to 85 deg C (185 deg F) without buckling, excessive stress on glass, joint seal failure, excessive stress on structural elements, damaging loads on fasteners, performance reduction, or other detrimental effects.
- .3 Structural Design:
 - .1 Wind Loads: Design unit skylights to withstand wind loads based on Limit States Design and 1 in 50-year return period in accordance with requirements of the Applicable Building Code for geographical location of the Project.
 - .2 Snow Loads: Design unit skylights to withstand snow loads based on Limit States Design and in accordance with requirements of the Applicable Building Code for geographical location of the Project, but not less than 2.4 kPa (50 psf).
 - .3 Deflection: Limit deflection to L/180 or 25 mm (1 inch), whichever is less.
 - .4 Air infiltration through skylight: must not exceed ~~0.3-0.5~~ L/s-m² (~~0.060.1~~ cfm/ft²) of fixed wall area plus permissible allowance specified for operable windows and doors within test area when tested in accordance with ASTM E283 at static air pressure difference of 300 Pa (~6.26 psf)
 - .5 Water Penetration: There must be no uncontrolled water penetration when skylight system is tested per ASTM E331 at 20% of maximum inward and outward acting design wind pressure, but not less than 300 Pa (6.26 psf) or greater than 720 Pa (15.03 psf) or equivalent to ASTM E547.
 - .6 Provisions must be made for water entering system from the exterior to be drained back to exterior.
 - .7 Maximum Water penetration: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters or water that is drained to exterior.

- .8 Solar Heat Gain Coefficient (SHG): Not more than 0.5
- .9 VLT: 48%
- .10 U-Value (imperial): Not more than 0.7

2.4 PYRAMIDAL RECTANGULAR CURB MOUNT SKYLIGHTS

- .1 Frame Composition: Corrosion-resistant extruded aluminum base frame, 6063-T5 alloy, with 76 mm (3 inches) aluminum mounting flange, heliarc welded corners, and 51 mm (2 inches) thermal insulation with rigid vinyl thermal break. Provide 8-degree sloped condensation gutter and co-extruded rubber draft seal.
- .2 Material: 6063-T5 aluminum alloy, heliarc welded corners.
- .3 Glazing: Sealed double acrylic ~~domepyramids~~.
- .4 Curb: Minimum ~~100 mm (4 inch) 38 mm (1-1/2 in) high, mill finish aluminum, two-piece construction; as indicated on Drawings.~~
- .5 Outer and inner wall: 1.27 mm (0.050 in).
- .6 Insulation: 50 mm (2 in) thick fiberglass
- .7 Mounting Flange: 75 mm (3 in) aluminum mounting flange.
- .8 Size: Refer to Drawings.
- .9 Basis-of-Design: "~~Model P-PVCCM Aluminum Base Frame -- Model FF~~" by Artistic Skylight Domes.

2.5 MATERIALS

- .1 Aluminum: Aluminum Sections: ASTM B209M, size accurately formed as shown on Drawings, extruded aluminum alloy AA-6063-T5 for all aluminum except surfaces receiving anodizing which shall be AA-6061-T6. Surfaces shall be free from defects impairing appearance, strength and durability.
- .2 Frame: Extruded aluminum, perimeter curb frame with thermal break, continuous extruded aluminum intermediate support frame with integral sloped condensation gutter, extruded aluminum retainer straps, extruded aluminum ~~domepyramid~~ retaining frame screw attached to curb frame and integrally fitted with ~~domepyramid~~ compression gasket. Provide holes for positive non-plugging drainage of condensation gutter. Include curb frame splice and expansion joint cover.
- .3 Gaskets: extruded resilient vinyl or neoprene.
- .4 Integral Glazing Gaskets: Continuous EPDM, Santoprene silicone, butyl rubber or neoprene designed specifically for use in aluminum frame section and held under constant pressure. Seal end-to-end joints by fusion.
- .5 Seals: closed cell neoprene sponge, compressible, with full recovery after 50% compression.
- .6 Screws: Stainless Steel.
- .7 Isolation coating: Alkali resistant bituminous paint or epoxy coating.

2.6 AUXILIARY MATERIALS

- .1 Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic, nominally free of sulfur and containing no asbestos fibers, formulated for 15-mil dry film thickness per coating.

- .2 Elastomeric Sealant: ASTM C 920; Type S; Grade NS; Class 25; and Uses NT, G, A, and (as applicable to joint substrates indicated) O; recommended by unit skylight manufacturer and compatible with joint surfaces.
- .3 Elastomeric Sealant: ASTM C920; Type S; Grade NS; Class 25; and Uses NT, G, A, and (as applicable to joint substrates indicated) O; recommended by unit skylight manufacturer and compatible with joint surfaces.
- .4 Fasteners: stainless steel or cadmium-plated steel. Ensure exposed fasteners match the adjacent aluminum colour.
- .5 Gaskets: Continuous co-extruded vinyl, neoprene, EPDM, or Santoprene rubber under constant pressure.
- .6 Weep Holes: Provide condensation management system with weep holes to ensure proper drainage.

2.7 FABRICATION

- .1 Fit and assemble Work in shop. Execute Work in accordance with details and reviewed Shop Drawings.
- .2 Fabricate extruded aluminum square frame from alloy AA-6063-T5 free from defects impairing appearance, strength.
- .3 Fabricate Work square, true, straight, plumb and level, accurately to size detailed and free from distortion, waves, twists, buckles or other defects detrimental to appearance or performance.
- .4 Provide method of securing edge of flexible flaps for air seal continuity to building air/vapour barrier.
- .5 Equip curb with an integral metal cap flashing of same thickness and material as curb, fully welded at corners for absolute weather tightness. Ensure insulation on exterior of curb is rigid polyurethane or glass fibre board minimum 50 mm (2") in thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Site Verification of Conditions: Verify actual site dimensions and location of adjacent materials prior to commencing work. Notify Consultant in writing of any conditions which would be detrimental to the installation. Commencement of work implies acceptance of previously completed work.

3.2 INSTALLATION

- .1 Installation, generally: Install work of this Section in strict accordance with manufacturer's written installation instructions and reviewed Shop Drawings. Supplement manufacturer's installation instructions with additional installation requirements specified in this Section to produce specified work results.
- .2 Install unit skylights in accordance with the construction details provided in the CRCA's "Canadian Roofing Reference Manual", CSA A440 and AAMA 1607.
- .3 Where metal surfaces of units will contact incompatible metal or corrosive substrates, including wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation recommended in writing by unit skylight manufacturer.
- .4 Anchor unit skylights securely to supporting substrates.

- .5 Set unit skylight flanges in thick bed of roofing cement to form a seal, unless otherwise indicated.
- .6 Where cap flashing is indicated, install to produce waterproof overlap with roofing or roof flashing. Seal with thick bead of mastic sealant except where overlap is indicated to be left open for ventilation.

3.3 FIELD QUALITY CONTROL

- .1 Water Leakage Testing: After installation is complete and sealants and glazing compounds have cured nominally, but before interior finishes are installed, test each skylight unit for water leaks in accordance with AAMA 501.2.
- .2 Work will be considered defective if it does not pass tests and inspections.
- .3 Additional testing and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- .4 Prepare test and inspection reports.

3.4 CLEANING

- .1 Remove protective materials from ~~dome~~pyramid. Wash with mild soap and water solution. Rinse clean.

END OF SECTION

PART 1 - GENERAL

1.1 PRICING

- .1 All costs associated with the work required by and associated with this Section shall be included as part of the Contract Price and in the price listed in item #1 of the Bid Form.

1.2 GENERAL INSTRUCTIONS

- .1 Read and conform to:
 - .1 the General Conditions and the Supplementary Conditions of the Contract;
 - .2 Division 1 requirements and documents referred to therein.

1.3 SUMMARY

- .1 Work Included:
 - .1 Provide glass and glazing for applications including, but not limited to the following:
 - .1 glazing for architectural woodwork.
 - .2 glazing for hollow metal doors.
 - .3 glazing for borrowed lites and screens.
 - .4 glazing for flush wood core doors.
 - .5 glazing for aluminum doors, entrances and storefronts.
 - .6 miscellaneous specialty glass, gaskets, tapes and glazing materials
- .2 Related Requirements: Specifications throughout the entirety of the Divisions of this Project are directly applicable to this Section, and this Section is directly applicable to them

1.4 REFERENCES

- .1 Reference Standards: Latest published editions of reference standards listed in this Section in effect as of the closing date and time of the Request for Tenders for the Contract, including any amendments adopted, are applicable unless otherwise indicated.

1.5 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings:
 - .1 Prior to starting work of this Section, convene a pre-installation meeting at the Project site to review the Project requirements and site conditions with pertinent parties. Conform to requirements of Section 01 30 00.
 - .2 In particular address the following items:
 - .1 Prior to commencing work of this Section arrange for the manufacturer's technical representative to review with, the Contractor and Consultant, procedures to be adopted and conditions under which work shall be performed. Inspect surfaces to determine adequacy of existing and proposed conditions.
 - .2 Coordinate installation with related Sections referenced herein.
 - .3 Coordinate and verify with tempered glass manufacturer criteria for roll wave factor (RW) to ensure optimal flatness in the glass assemblies;

- .4 Cooperate fully with Subcontractors that are performing the work of other Sections and promptly proceed with the work of this Section as rapidly as job conditions permit.
- .5 Cooperate. Cooperate with Subcontractors that are performing the work of other Sections for the application of all miscellaneous specialties.
- .6 Supply items to be built-in in ample time to be incorporated into work of other Subcontractors, together with measurements and other information required for location of it.
- .7 Ensure work which may create dust does not proceed during work related to painting and final finishing.

1.6 SUBMITTALS

- .1 Product Data: Submit manufacturer's literature and data sheets for each type of material provided under this Section for the Project in accordance with requirements of Section 01 30 00. Ensure data sheets provide required information including detailed instructions for installing as well as maintaining, preserving and keeping materials in clean and safe conditions. Provide adequate warning of maintenance practices or cleaning agents detrimental to specified materials. Provide gloss measurements for acid etched glazing.
- .2 Safety Data Sheets (SDS): Submit SDS for inclusion in Operation and Maintenance Manual specified in Section 01 70 00, for adhesives, sealants and any other material designated by Consultant.
- .3 Samples: Submit samples of materials identifying quality and type of glass if required by Consultant before commencing work. Ensure samples are clearly labelled with manufacturer's name and type. Submit the following samples:
 - .1 fire resistive glass
 - .2 mirrors,
 - .3 decorative glass
 - .4 film types including decorative types and custom films with graphics and special colours.
 - .5 etched glass
 - .6 bird deterrent glass
- .4 Test and Evaluation Reports:
 - .1 Provide adhesion test reports on metal and glass tested in accordance with ASTM C794, 14 Day cure and 7 Day submersion.
 - .2 Provide to sealant manufacturer, Shop Drawings showing size of lites, design loads and sealant dimensions for sealant manufacturer's evaluation and statement on stress.
- .5 Shop Drawings: Submit Shop Drawings in accordance with Section 01 30 00. Ensure Shop Drawings indicate material characteristics, details of construction, connections and relationship with adjacent construction. Where required, ensure Shop Drawings are prepared and stamped by a Professional Engineer licensed in the Province of Ontario.
- .6 Product Certificates:
 - .1 Submit certificates signed by manufacturers of glass and glazing Products certifying that Products furnished comply with requirements of this Section. In particular, submit data substantiating that tempered, laminated and insulated glazing units are tested in accordance with applicable standards specified herein.
 - .2 Adhesion and Compatibility: Provide compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials were tested for compatibility and adhesion

with glazing sealants. Include sealant manufacturers interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed for adhesion.

- .7 Maintenance Data: Provide maintenance data indicating cleaning instructions for inclusion into the maintenance manual in accordance with the requirements of Section 01 70 00.

1.7 QUALITY ASSURANCE

- .1 Installer's Qualifications:
 - .1 Ensure work of this Section is performed by an experienced installer trained, experienced and familiar with glass and glazing methods and standards specified herein.
 - .2 Provide work of this Section executed by competent installers with a minimum 5 years' experience in the application of the Products, systems and assemblies specified herein and with the approval and training of the Product manufacturers.
- .2 Fabricator's Qualifications:
 - .1 Insulating Glass Fabricator: Ensure fabricator belongs to Certified Fabricator Program and comply with CAN/CGSB 12.8 and/or ASTM E2190 testing.
 - .2 Provide work of this Section executed by manufacturer having 10 years' experience in the manufacture and fabrication of the glass and glazing of type and quality shown and specified herein. Submit proof of experience upon request.
- .3 Licensed Professionals: Employ a full time structural Professional Engineer registered in the Province of Ontario, carrying minimum \$2,000,000.00 professional liability insurance, to:
 - .1 design the components of the Work of this Section requiring structural performance in accordance with applicable codes and regulations, review design documents, and Provide site administration and inspection of this part of the Work.
- .4 Single Source Responsibility: Ensure primary materials provided in this Section are obtained from 1 source by a single manufacturer and secondary materials are obtained from sources recommended by primary materials manufacturers.
- .5 Preconstruction Testing: Submit to sealant manufacturer samples of each type of glass, gasket, glazing accessory and glass framing member that will contact or affect glazing sealants for compatibility and adhesion testing. Submit test samples in sufficient time for testing and analysis of results to prevent delay in progress of work.
- .6 Mock-ups:
 - .1 Provide mock-ups in locations designated by the Consultant and as specified in individual Sections for glazed systems and assemblies to demonstrate quality of workmanship.
 - .2 Prior to full production and final installation of tempered glass, submit full-size mock ups of glass assemblies; Ensure roll wave in glass assemblies are placed parallel to window sill. Allow the Consultant to view the assemblies in conditions similar to the Project locations under various light exposures and times of Day to establish acceptable optical distortion.
 - .3 Maintain mock-ups during construction in an undisturbed condition as a standard for judging the completed work.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Delivery and Acceptance Requirements: Deliver glass and associated materials to Site in original crates and containers with the manufacturer's name and brand distinctly marked thereon and with glass labelled as to types. Do not remove labels on glass until after work is accepted by the Consultant.

- .2 Storage and Handling Requirements: Store materials within the building, in a clean, dry location, acceptable or as designated by the Consultant. Fully protect materials from damage of any kind until ready for use.

1.9 PROJECT CONDITIONS

- .1 Environmental Requirements: No glazing done when temperature is less than 7 deg C (44 deg F) or sash or frames are wet, damp or frosted.
- .2 Protect work of other trades from damage resulting from the work of this Section.
- .3 Identify glazed openings immediately following glass installation. Use coloured tapes or flags suspended near, but not in contact with glass. Attach to frames or surround with suitable non-staining strippable adhesives or tapes.

1.10 WARRANTY

- .1 The Contractor warrants mirrors for period of 10 years from Substantial Performance of the Work against defects and/or deficiencies in accordance with the General Conditions of the Contract. Promptly correct any defects or deficiencies which become apparent within this warranty period, to the satisfaction of the Consultant and at no expense to the Owner. Defects include but are not limited to: visual distortion, deterioration of silvering on mirrors.
- .2 The Contractor warrants laminated glass for period of 5 years from Substantial Performance of the Work against defects and deficiencies in accordance with the General Conditions of the Contract. Promptly correct defects or deficiencies which become apparent within this warranty period, to the satisfaction of the Consultant and at no additional expense to the Owner. Defects include but are not limited to: deterioration, edge separation, delamination, material obstructing vision glass and blemishes exceeding those allowed by GANA (LGSA) standards. Upon notification of such deterioration within the warranty period, Provide full replacement of glass units showing defects at no additional cost to Owner.
- .3 The Contractor warrants fire resistive glass for a period of 5 years against defects and/or deficiencies in accordance with the General Conditions of the Contract.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 Comparable Products from the manufacturers listed herein will be considered provided they meet the requirements of the Drawings, schedules and this Specification, offering functionally, aesthetically equivalent Products in the Consultant's opinion and subject to Consultant's review.
 - .1 Glass and Glazing:
 - .1 AGC Flat Glass North America, Ltd.
 - .2 Guardian Industries Corp.
 - .3 McGrory Glass
 - .4 Pilkington Special Glass Limited
 - .5 PPG Canada Inc.
 - .6 Schott North America Inc.
 - .7 Trulite Industries Limited
 - .8 Viracon
 - .9 TGP
 - .10 Walker Glass
 - .2 Architectural Decorative Glass

- .1 AGC
- .2 Goldray Industries Ltd.
- .3 Skyline Design
- .4 Walker Glass, or
- .3 Polycarbonate Mirrors:
 - .1 Plaskolite, Inc;
 - .2 Curbell Plastics, Inc.
- .4 Convex Surveillance Mirrors:
 - .1 CR Laurence;
 - .2 Security Mirror Industries Ltd.
- .5 Glazing Security Films:
 - .1 3M Films;
- .6 Glazing Decorative Films:
 - .1 Decorative Films;
 - .2 Llumar;
- .7 Glazing Sealants and Gaskets:
 - .1 Dow Corning;
 - .2 GE Silicones;
 - .3 Tremco Canada;

2.2 DESCRIPTION

- .1 Regulatory Requirements:
 - .1 Fire-Resistive Characteristics:
 - .1 Fire rated door assemblies shall comply with NFPA 80; tested, inspected according to NFPA 257 and shall be acceptable to Authorities Having Jurisdiction.
 - .2 Where required (60, 90 min Doors, 120 mins) Provide fire resistive glass tested in accordance with CAN/ULC S101 as applicable and acceptable to Authorities Having Jurisdiction for specific application.
 - .2 Glass and glazing used in this Project shall be designed in conformance with these Specifications, CAN/CGSB-12.20-M, the OBC and regulations of Authorities Having Jurisdiction. In case of conflict, the Contractor shall comply with most stringent requirements.
 - .3 Glass and glazing systems shall be, where applicable, watertight and airtight capable of withstanding thermal movement and wind and impact loads without failure of any kind, including loss or breakage of glass, failure of seal or gaskets, exudation of glazing sealants, and excessive deterioration of glazing materials.
- .2 Design and Performance Requirements:
 - .1 Provide glass for work of this Section free from bubbles, waves, discolouration and other defects, of types specified herein for locations indicated on Drawings or noted on Door Schedules. Ensure glass bears manufacturer's label indicating quality and testing agency certifications. Leave labels in place until final cleaning.
 - .2 Perform work of this Section in accordance with GANA - Glazing Manual; www.glasswebsite.com and LSGASM - Standards Manual for laminated glazing installation methods.

- .3 Ensure insulating glass units are manufactured in accordance with Insulating Glass Manufacturing Quality Procedures; www.igmaonline.org
- .4 Determine optical distortion in accordance with ASTM C1652 requirements of fully tempered glass substrates which have been processed in a heat controlled continuous or oscillating conveyance oven; Measure the wavelength and amplitude of the roll wave factor (RW) of glass panel using planer grid, a digital camera and other software that meets ASTM C1652 requirements.
- .5 Deflection: Limit glass deflection to flexural limit of glass with full recovery of glazing materials.
- .6 Confirm glazing material thicknesses by analyzing Project loads and in-service conditions. Provide glazing material for various size openings in nominal thicknesses indicated, but not less than thicknesses and in strengths required to meet or exceed performance criteria.
- .7 Human Impact Load Resistance: Provide glazing materials listed and labeled as complying with testing requirements of ANSI Z97.1 - Class A.
- .8 Ensure solvents and/or other volatile elements in glazing system do not affect properties and performance of materials used for edge seal and sealant glass bond.
- .9 Ensure materials used for edge seals are compatible with other materials they come in contact within the glazing system. If required, perform compatibility tests to ASTM C510, ASTM C794 and ASTM C1087, or others as applicable.
- .10 Use sealants and other materials in glazing system which are unaffected by long term UV light exposure.

2.3 MATERIALS

- .1 Heat Strengthened Glass (HSGL): Conforming to ASTM C1048, Kind HS minimum 6 mm (1/4"). Perform heat strengthening using horizontal tong free method; surface compression in range of 3,500 to 7500 psi, preferably no higher than 5000 psi.
- .2 Tempered Glass (TGL/CGL): Conforming to ASTM C1048, Kind FT or CAN/CGSB-12.1-M, Type 2 tempered, Class B float glass, Category II, minimum 6 mm (1/4"). Perform heat strengthening using horizontal tong free method; surface compression not less than 10,000 psi.
 - .1 Visual Distortion: Ensure glass is tempered by the horizontal toughening process only and conforms to the following roll wave factor (RW) limits measured in accordance with ASTM C1652 requirements:
 - .1 Roller Wave: +/- 0.15 mm over 300 mm.
 - .2 Edge Dip: 0.25 mm maximum.
 - .2 Provide at all locations unless indicated otherwise.
 - ~~.3 Laminated Glass (GL-1 and GL-1A): Provide glass laminated to interlayers to produce laminated lites free of foreign substances, air and glass pockets. [TBD]~~
 - ~~.1 Interlayer: clear PVB interlayer of thickness as indicated in specific assemblies.~~
- .4 Intumescent Fire Resistive Glass (~~FRGLI~~)-(FGLI)
 - .1 Conforming to CAN/ULC S101 for fire resistance rating indicated; and impact and safety rated in accordance with ANSI Z97.1 – Class A.
 - .2 Provide units composed of multiple layers of annealed glass as specified herein laminated with intumescent interlayer in thicknesses required to suit design and fire resistive requirements.
 - .1 Acceptable Products:

- .1 "Pyrostop" by Pilkington; or
 - .2 "Contraflam" by VetroTech;
 - .3 "Pyrobel" by AGC; or
 - .4 "Superlite II-XL" by SaftiFirst;
 - .5 or Equivalent to the above.
- .2 Provide at all fire-rated locations unless indicated otherwise.
- ~~.5 Polycarbonate Security Glazing (SGL)~~
 - ~~.1 Glass-Clad Polycarbonate: ASTM C 1349, and other requirements specified.~~
 - ~~.2 Bullet Resistance Protection Level: Level 3 per UL 752~~
 - ~~.3 Minimum Overall Unit Thickness: 30 mm (1-3/16 inch)~~
 - ~~.4 Unit Makeup: Multiple Laminations of glass and polycarbonate as necessary to meet performance requirements specified in this Section. Exposed polycarbonate is not acceptable.~~
 - ~~.5 Acceptable Manufacturers:~~
 - ~~.1 Global Security Glazing~~
 - ~~.2 OldCastle Glass~~
 - ~~.3 Prelco.~~
 - ~~.4 or Equivalent to the above.~~
 - ~~.6 Spall-Resistant Film: Provide composite of clear polyvinyl butyral film and clear abrasion-resistant polyester film. Provide on threat side.~~
 - ~~.1 Acceptable Products: DuPont Glass Laminating Solutions, DuPont Company; SpallShield or approved Equivalent.~~
- .6 Frameless Mirrors (~~MIR-3 and MIR-4~~):
 - .1 Conforming to ASTM C1503, Mirror Select Quality, size(s) as shown on Drawings, 6 mm (1/4") thick float glass with process deposit of 5 silver coats, 3 copper coats and final protective seal.
 - .2 Mirror Adhesive: Compatible with silver coatings, copper coatings and protective seal applied to mirrors, recommended by manufacturer to hold mirrors permanently in position without visible signs of mirror deterioration throughout warranty period. Provide Low-VOC mirror adhesive material recommended by the glass fabricator.
 - .3 Edge Treatment: Square and polished. Silvered Seal edges after edge treatment to prevent chemical or atmospheric penetration of glass coating.
 - .4 Extruded-Aluminum Top and Bottom Trim: 1.3 mm (0.05") thick aluminum J-channels with return that produces glazing channel to accommodate mirrored glass thickness indicated.
 - .1 Bottom Trim: J-channels formed with front leg and back leg, and not less than 20 mm (7/8") in height.
 - .1 Acceptable Products: "CRL Standard Bottom J Channel Series" by CR Laurence; or equivalent.
 - .2 Top Trim: J-channels formed with front leg and back leg, and not less than 25 mm (1") in height.
 - .1 Acceptable Products: "CRL Standard Top - J-Channel Series" by CR Laurence; or equivalent.
 - .3 Aluminum Finish: Satin anodized.

- .7 Thermally Insulated Glazing Materials: Refer to Section 08 44 00.
- .8 Glazing Films:
 - .1 Dimensionally stable cast film, minimum 0.05-mm (2-mil) thick, with pressure-sensitive clear adhesive back for adhering to glass and releasable protective backing.
 - .2 Provide film with factory edge with maximum tolerance of 1.5 mm (1/16") gap between film edge and glass stop. Provide tamper-resistant clear sealant at edges of film at glass stops.
 - .3 Locate films on glass doors and other glazed areas indicated on Drawings and Schedules to meet code requirements. Apply film to non-public side of glass unless noted otherwise.
 - .4 Film Colours and Graphics: to be determined at a later date by Consultant from manufacturer's full range including custom colours to match approved samples.
 - .5 Apply films in sizes, extents and cutouts to suit design requirements.
 - .6 Security Films (FILM-S): Provide security Film "Ultra S800 Series" by 3M or equivalent by Ace Security Laminates. Provide film conforming to CPSC 16 CFR Category II (400 ft/lb) and ANSI Z97.1. Colour: As selected by the Consultant at a later date.
 - .7 Decorative Film Types:
 - .1 Translucent Film (FILM1): Provide "SOLYX SXWF-WF White Frost" by Decorative Films or Equivalent by 3M or Llumar.
 - .2 Opaque Film (FILM2): Provide "SOLYX SXWF-WB White/Black Out" by Decorative Films or Equivalent by 3M or Llumar.
- .9 Glazing, Sealing Compounds and Accessories:
 - .1 Ensure glazing, sealing compounds and accessories are compatible with all contact surfaces of frames, accessories used in glazing system and contact surfaces of compounds used in glazing systems. Wood or other organic materials are not acceptable for use in glazing systems.
 - .2 Glazing Compound: Non-hardening modified oil type. Colour to match adjacent surfaces unless indicated otherwise.
 - .3 Sealant Compound: In accordance with Section 07 92 00. Provide one component type, elastomeric chemical curing, CAN/CGSB-19.13-M, Class G-2-25-A-N or ASTM C920, Type S, Grade NS Class 25 or one component, silicone base solvent curing. Colour: to match adjacent surfaces unless indicated otherwise.
 - .4 Elastomeric Joint Sealants: In accordance with Section 07 92 00 and ASTM C920.
 - .5 Sealant for Interior Non-Structural Glass-to-Glass Butt Glazing Installation: Translucent 1 part silicone sealant conforming to CAN/CGSB-19.13-M and ASTM C920, "Tremsil 200" by Tremco Canada or "DC 999" by Dow Corning Canada.
 - .6 Cellular Gaskets for Compression Glazing: ASTM C509 cellular, elastomeric, preformed, black. Closed cell neoprene or EPDM extrusions including molded corners where applicable by Tremco Canada or Equivalent.
 - .7 Dense Gaskets for Compression Glazing: ASTM C864, Option II or ASTM C1115, Type C, dense neoprene or EPDM extrusions, 60 and 70 Durometer density including molded corners where applicable by Tremco Canada or Equivalent.
 - .8 Glazing Splines: Neoprene or EPDM manufacturer's standard dry glazing splines to suit aluminum extrusions. Colour to match adjacent surfaces unless indicated otherwise.
 - .9 Glazing Points and Wire Spring Clips: Corrosion resistant, manufacturer's standards.
 - .10 Edge Blocking for Glass: 60 - 70 Durometer neoprene, silicone or EPDM, channel shaped, 100 mm - 150 mm (4" - 6") long.

- .11 Setting Blocks: 7 mm x 100 mm (5/16 x 4") EPDM or extruded 80-90 Durometer neoprene. Width: 1.6 mm to 3 mm (1/16" to 1/8") less than design glazing pocket width.
 - .1 Only use EPDM at insulating glass units.
 - .2 At fire-rated glazed doors and partitions, use similar sized fire-rated silicone as recommended by the fire-rated glass manufacturer and identical to Product used in test assembly to obtain rating.
- .12 Lateral Shims: Neoprene, silicone or EPDM, 40 - 60 Durometer, 100 mm (4") long or as required.
- .13 Compression Glazing Gaskets for interior aluminum frame glazing: EPDM, neoprene, thermoplastic or other acceptable material with Shore A Durometer of 35 (\pm 5). Ensure material has sufficient thickness to allow 25% compression when installed. Provide "VISIONstrip®" by Tremco Canada or Equivalent by Armet, Dow Corning or PTI (or Equivalent) having the following characteristics:
 - .1 Resistance to permanent set: 30% maximum
 - .2 Tensile Strength: 2000 psi (1500 psi for silicone) minimum
 - .3 Minimum elongation at break: 300% (700% for silicone)
- .14 Compression Glazing Tape: "Polyshim II Tape" by Tremco Canada or Equivalent with 60 durometer hardness. Ensure tape is sufficiently wide and thick to completely cover bite area of glazing unit when unit is pushed into place.
- .15 Interior Structural Glazing Sealant:
 - .1 In accordance with Section 07 92 00. Provide one component, chemical curing, silicone based sealant, conforming to ASTM C1184 and CAN/CGSB-19.13-M (Classification MCG-2-25-A-N) unless otherwise indicated.
 - .2 Ensure sealant is UV resistant, ozone resistant, non-bleeding, non-staining and capable of supporting its own weight, weight of glazing units and other specified or referenced loads to meet design criteria; in conformance with OBC requirements. Where applicable, ensure silicone sealant is compatible with edge-seal of insulated glass units. Acid curing is not acceptable.
 - .3 Acceptable types for shop glazing: "Proglaze II Multi Component" by Tremco Canada; or "Ultraglaze 4400" (where recommended by manufacturer) by GE Silicones; or "DC-983" by Dow Corning Canada (or Equivalent).
 - .4 Acceptable types for field glazing: "Spectrum® 2 or Proglaze SG" by Tremco Canada; or "Ultraglaze 4000/4400" by GE Silicones; or "DC-795" by Dow Corning Canada (or Equivalent).
- .10 Primer Sealers and Cleaners: To glass and plastic glazing manufacturer's standards.

2.4 FABRICATION

- .1 Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of Product manufacturer and referenced glazing standard, to comply with system performance requirements.
- .2 Label each lite of glazing with registered name of Product and weight and quality.
- .3 Check dimensions on job site before cutting materials.
- .4 Grind and chamfer edges of unframed glass and mirrors. Grind and chamfer edges of glass shelves and sliding doors.
- .5 Ensure minimum bite or lap of glazing on stops and rabbets as recommended by glazing manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Site Verification of Conditions:
 - .1 Verify actual site dimensions and location of adjacent materials prior to commencing work.
 - .2 Obtain glass dimensions on the job site. Ensure glass is not more than 4 mm (3/16") less than rebate size in either dimension, with allowance for edge spacers, shims and setting blocks as required.
 - .3 Ensure framing to be glazed is plumb, secure and permanently fixed in position.
 - .4 Notify the Consultant in writing of any conditions which would be detrimental to the installation. Commencement of work implies acceptance of previously completed work.

3.2 PREPARATION

- .1 Thoroughly clean glass rebates and glass of dust, dirt, mortar and other foreign materials prior to glazing. Remove oils and grease with non-staining solvents such as Xycol or Methyl Ethyl Ketone solutions.
- .2 Properly prime, before glazing, glazing rebates in wood doors.

3.3 INSTALLATION

- .1 If required, thoroughly mix glazing compound as recommended by manufacturer. Thinning of glazing compound will not be permitted.
- .2 Carefully remove glazing stops and replace after glazing. Take care to prevent damage to stops.
- .3 Doors, Screens, Sidelites and Interior Windows:
 - .1 Place setting blocks on sill at 1/4 points from each corner unless otherwise directed by glazing manufacturer.
 - .2 Place continuous glazing gaskets on edges of glass.
 - .3 Centre and space each piece of glass with spacers located and installed according to manufacturer's directions.
 - .4 Place glass so no voids occur between glass and glazing material, and glazing stops.
 - .5 Secure glass in place with stops, secured in place with screws.
- .4 Glazing Sealant:
 - .1 Compatibility: Select sealants with proven compatibility with surfaces contacted in installation and under service conditions indicated, as demonstrated by testing and field experience.
 - .2 Apply glazing sealant to clean, dry, grease and oil free surfaces. Provide exposed glazing sealant smooth, free from ridges, wrinkles, air pockets and embedded foreign materials.
 - .3 Prime surfaces if required by the glazing sealant manufacturer.
 - .4 Trim glazing sealant flush with tops of stops and glazing channels.
 - .5 Remove excess glazing sealant or droppings which would set up or become difficult to remove from finished surfaces. Remove excess sealant immediately. Do not use chemicals, scrapers, or other tools which would affect finished surfaces.

- .5 Interior Glazing:
 - .1 Fire Rated Hollow Metal Doors and Screens:
 - .1 Set glass in fire rated metals doors and screens on continuous setting block with 3 mm (1/8") gap between glazing stop glass and embed in glazing compound in accordance with NFPA 80 and the OBC requirements. Strike and point exposed joints between metal and glass or Install glass in accordance to ULC tested proprietary methods of installation.
 - .2 Tape/Tape Method:
 - .1 Cut glazing tape to proper length and Install against permanent stop projecting 1.5 mm (1/16") above sightline.
 - .2 Place glazing tape on free perimeter of glass projecting 1.5 mm (1/16") above sightline.
 - .3 Trim off excess tape to sightline.
 - .3 Combination Method-Tape/Sealant:
 - .1 Cut glazing tape to proper length and Install against permanent stop projecting 1.5 mm (1/16") above sightline.
 - .2 Fill gap between glass and applied stop with sealant to depth equal to bite of frame on glass to uniform and level line.
 - .3 Trim off excess tape to sightline.
 - .4 Compound/Compound Method:
 - .1 Apply sealant to back and bottom of rabbet.
 - .2 Bed glass in position with non hardening compound sealant.
 - .3 Position and secure glass of smaller dimension only using spring wire or glaziers' clips. Apply face compound and trim sealant to slope away from light, OR Fill gaps between glass and stops with compound until flush with sightline and tool to smooth straight line.
 - .5 Dry Method (Gaskets):
 - .1 Place gasket against permanent stop and position glazing sheet.
 - .2 Apply removable stops. Install gaskets in frame channels.
 - .6 Combination Method-Tape/Gasket for intermediate and large acrylic or polycarbonate lights over 600 mm x 600 mm (24" x 24"):
 - .1 Cut glazing tape to proper length and Install against permanent stop.
 - .2 Position glass.
 - .3 Apply removable stops and Install gaskets in frame channel.
 - .7 Two Sided Butt - Joint Glazing:
 - .1 2 side glazing at head and sill use wet, dry, or wet/dry glazing systems.
 - .2 Position glazing so that vertical edges are spaced slightly apart and seal with silicone sealant.
 - .3 Grind vertical joint with slight kerf and polish for aesthetics.
 - .8 Window Film:
 - .1 Install window film in accordance with the manufacturer's printed instructions by experienced film applicators as recommended by the glass film manufacturer.
 - .2 Ensure glass surfaces are clean and ambient temperature is between 16 deg C and 38 deg C (61 deg F and 100 deg F).

- .3 Whenever 2 or more pieces of the same colour translucent film are seamed together as a continuous band of colour, they shall be matched to assure uniform reflected daytime colour and transmitted night appearance.
- .6 Mirrors:
 - .1 Install mirrors where indicated on the Drawings. Install mirrored glass units to comply with written instructions of the mirrored glass manufacturer and with referenced GANA and NAAMM publications. Mount mirrored glass accurately in place in a manner that avoids distorting reflected images.
 - .2 Mount plumb and level and accurately in position and secure rigidly in position.
 - .3 Ensure back-up wall surface is thoroughly dry, smooth and firm and primed.
 - .4 Provide space for air circulation and elimination of condensation between back of mirror and wall.
 - .5 Install frameless mirrors with mirror edges ground and polished.
 - .1 Locate joints in mirrors to the Consultant's direction. Generally joints are acceptable only for locations where mirrors are longer than 2400 mm (8'-0"). Provide butt joints with ground and polished edges. Apply 6 mm (1/4") wide clear silicone bead at butt joints.
 - .2 Secure wall and ceiling mirrors in place over special adhesive, temporarily fixing in place until adhesive sets.
 - .3 Set mirrors with J-trims specified in this Section. Anchor rigidly to wall construction.
- .7 Security One Way Mirrors:
 - .1 Install security one way tempered mirrors where indicated on Drawings.
 - .2 Mount plumb and level and accurately in position and secure rigidly in position.
 - .3 Install security one way tempered mirrors according to manufacturer's directions. Ensure reflective surface shall be facing brightly lit subject side.
 - .4 Subject side lighting shall be bright and evenly distributed over all walls and furnishings, but shall not be shining directly onto one way tempered mirrors. Subject side shall be bright and light in colour and shade to create a bright reflected image.
 - .5 Observer side lighting shall be dim with no open light sources. Observer side decorations shall be subdued, non-reflective, dark and uniform. Observer side people, objects and light source shall be at reasonable distance from one way tempered mirror area.
 - .6 Maintain 8:1 light ratio with subject lit brightly.
 - .7 Install mirrors with frames according to manufacturer's direction. Use concealed tamper proof fasteners in addition to adhesive where required.

3.4 PROTECTION

- .1 Provide and maintain necessary protection of completed work against damage.
- .2 Do not mark or attach anything directly to exposed glass and framing surfaces.
- .3 If welding is to take place above or near completed glazing work, protect glass with plywood or other suitable means to reduce likelihood of weld spatter damaging glass surfaces.
- .4 Protect glass from other trades, workers, tools and other similar materials.
- .5 Replace cracked, broken, or defective glass at no additional cost to the Owner and to the Consultant's satisfaction.

- .6 Identification of Glazing: Mark glass lites with temporary, easily removable, large safety markings, immediately after glass installation. Maintain safety markings until final clean-up.

3.5 CLEANING

- .1 Clean installed glass and metal frequently during construction. Avoid etching and staining glass and metal during construction.
- .2 Clean and polish glass. Remove labels.
- .3 Remove sealant and compound droppings from finished surface.
- .4 Periodically clean installed glass during construction to avoid permanent etching and staining.
- .5 Remove markings at time of final clean-up. Final clean-up shall be carried out in accordance with glass and sealant manufacturer's recommendations to the Consultant's satisfaction.
- .6 Avoid storing materials adjacent to glass.
- .7 Protect glass from other trades.
- .8 At completion of work, replace any damaged (includes scratches) or broken glass provided under this Section with similar glass.
- .9 Wash glazing units on both exposed surfaces in each area of Project prior to scheduled inspections. Wash glazing units as recommended by the glazing unit manufacturer

3.6 INTERIOR GLAZING SCHEDULE

- .1 Refer to Drawings and Door and Frame Schedule.

END OF SECTION

PART 1 - GENERAL

1.1 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all products specified in this section, except piping and valves.

1.2 CLOSEOUT SUBMITTALS

- .1 Submit a letter from compressor manufacturer/supplier to certify proper compressor set installation as specified in Part 3 of this section.
- .2 Training attendance records.

1.3 QUALITY ASSURANCE

- .1 Compressed air piping system work is to be in accordance with the following:
 - .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code;
 - .2 ASME B31, Standards of Pressure Piping;
 - .1 ASME-B31.1 – Power Piping.
 - .3 ASME/ANSI B16 - Standards for Pipes and Fittings.
 - .4 and governing Provincial and/or Municipal Codes and Regulations.
 - .1 O.Reg. 220/01 - Boiler and Pressure Piping Regulation.

PART 2 - PRODUCTS

2.1 PIPE, FITTINGS AND JOINTS

- .1 Galvanized Steel
 - .1 Schedule 40 mild steel, galvanized, ASTM A53, screwed, complete with Class 125 galvanized cast iron screwed fittings and screwed joints.
- .2 Copper
 - .1 Type "L" hard drawn seamless copper to ASTM B88, complete with forged solder type fittings to suit pipe, and soldered joints using 95% tin / 5% Antimony solder.

2.2 PIPING UNIONS

- .1 Screwed Steel Piping
 - .1 Malleable iron, galvanized, ground joint, brass to iron or bronze to bronze seat unions and union elbows with a minimum pressure rating of 1725 kPa (250 psi) steam at 260°C (500°F).
- .2 Soldered Copper Piping
 - .1 Solder-on forged copper or bronze screwed unions suitable in all respects for the application.

2.3 LOW PRESSURE SHUT-OFF VALVES

- .1 Class 600, 4140 kPa (600 psi) WOG rated full port ball valves, each complete with a forged brass or bronze body with solder joint or screwed joint ends as required, forged brass cap and blowout-proof stem, forged brass chrome plated ball, "Teflon" or "PTFE" seat, and a removable lever handle.
- .2 Manufacturers:
 - .1 Toyo Valve Co. Fig. 5049A solder or Fig. 5044A screwed;
 - .2 Watts Industries (Canada) Ltd. #FBV-3 or #FBVS-3;
 - .3 Kitz Corporation Code 59 solder or Code 58 screwed;
 - .4 Apollo Valves #70-100 screwed or #70-200 solder.

2.4 HIGH PRESSURE SHUT-OFF VALVES

- .1 Equal to Apollo Valves #70-100-27, 4140 kPa (600 psi) rated Class 600, screwed bronze ball valve with a PTFE seat, automatic relief vent, and removable lever handle.

2.5 DRAIN VALVES

- .1 Minimum 2070 kPa (300 psi) water rated, 20 mm ($\frac{3}{4}$ ") dia. straight pattern full port bronze ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm ($\frac{3}{4}$ ") dia. garden hose, and a cap and chain.
- .2 Manufacturers:
 - .1 Toyo Valve Co. Fig. 5046;
 - .2 Kitz Corporation Code 58CC;
 - .3 Apollo Valves #78-100 or #78-200;
 - .4 Watts Industries (Canada) Ltd. #B6000-CC.

2.6 AIR COMPRESSOR SET

- .1 "Campbell Hausfeld", CE5002 compressor features a cast iron, oil lubricated 2 stage pumps. 175 PSI max pressure, 7.6 SCFM @ 90 PSI. 60-gallon ASME vertical tank design. Induction engine. ASME, UL, CSA certified.
- .2 Compressor set model number, performance and electrical characteristics as follows:
 - .1 model number: WBB2764020
 - .2 motor characteristics: 3.7 HP, 230 volts, 1 phase;
 - .3 tank capacity: 60 GAL
- .3 Each compressor complete with:
 - .1 cast iron cylinders, heads, crankcase, and cast iron connecting roads with replaceable automotive type insert bearings;
 - .2 cast iron crankshaft supported on both ends by oversized tapered roller bearings;
 - .3 pressure type oil lubrication with oil sight gauge;
 - .4 steel inlet and discharge valves, and a high efficiency intercooler with steel fins on copper tubes;
 - .5 heavy-duty dry type inlet filter-silencer;

- .6 high volume, statically balanced flywheel/cooing fan;
- .7 motor conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, on an adjustable support base, and V-belt drive with OHSA type steel belt guard, also as specified in Basic Mechanical Materials and Methods.
- .4 Welded steel receiver including an ASME rated tank in accordance with CSA B51 and TSSA requirements, complete with welded steel support feet, and following:
 - .1 ASME rated safety relief valve;
 - .2 positive seating ball type outlet valve, a screwed union, and a length of braided metallic flexible connection;
 - .3 pressure gauge with gauge cock;
 - .4 adjustable pressure switch for automatic start-stop operation of the compressors;
 - .5 valved manual tank drain, and an automatic tank drain;
 - .6 properly sized neoprene-steel-neoprene vibration isolating mounting pads;
 - .7 braided stainless steel flexible pipe connectors supplied loose.
- .5 Surface wall mounting power and control panel in a NEMA 1 (NEMA 2 if room is sprinklered) enamelled steel enclosure with a hinged (piano hinge) lockable front door, door interlock disconnect switch, and following:
 - .1 overload protected across-the-line, non-reversing magnetic starter, and a door mounted H-O-A switch for each motor, in accordance with Section 20 05 00 – Common Work Results for Mechanical;
 - .2 fused control transformer;
 - .3 electronic alternator to automatically alternate lead compressor after each start cycle, and to automatically start lag compressor should the lead compressor fail to start;
 - .4 door mounted "power on" LED for panel and door mounted "run" LED for each compressor;
 - .5 terminal block and strips for power and control wiring connections, including control wiring from receiver mounted pressure switch.
- .6 Manufacturers:
 - .1 CompAir Kellog;
 - .2 Atlas Copco Compressors Canada;
 - .3 DeVair Systems.
 - .4 Campbell Hausfeld.

PART 3 - EXECUTION

3.1 INSTALLATION OF AIR COMPRESSOR SET

- .1 Provide an air compressor set.
- .2 Secure set in place on vibration isolation on a concrete housekeeping pad.
- .3 Ensure housekeeping pad is keyed to structure, and compressor assembly is secured to structure by slack cable restraints. Refer to Section 20 05 48.16 - Seismic Controls for Mechanical Systems.
- .4 Install accessories shipped loose with set, except power and control panel.

- .5 Extend type DWV soldered hard copper drainage piping from tank drain assemblies to nearest floor drain.
- .6 Hand power and control panel to electrical trade at site for mounting and power wiring connections as part of electrical work.
- .7 Connect receiver pressure switch to starter and control panel with wiring in conduit to the standards of the electrical work and in accordance with panel supplier's instructions.
- .8 Touch-up paint any damage to the factory finish.

3.2 INSTALLATION OF PIPING AND PIPING SYSTEM COMPONENTS

- .1 Provide required compressed air piping. Unless otherwise specified, install horizontal piping to outlets 1.5 m (5 feet) above finished floor level.
- .2 Pipe is to be Schedule 40 mild galvanized steel, screwed, or type "L" hard copper, soldered.
- .3 Support and secure piping generally as specified in Section 20 05 00 – Common Work Results for Mechanical, but with extra support and securing hardware as required to prevent drumming. Provide rigid supports at each side of outlets.
- .4 Arrange piping so condensate will drain from mains and branches into drip legs. Provide drip legs at bottom of risers, every 30 m (100') of pipe run, and at the end of each branch piping run, whether indicated on drawings or not.
- .5 Drip legs are to extend down from bottom of pipe and consist of a piping tee and 250 mm (10") long pipe nipple same size as main or branch pipe, then a reducing fitting (if required) and 12 mm (½") dia. piping extended down to floor level and terminated with a ball valve. Ensure drain points are easily accessible and identified.
- .6 Extend branch piping to outlets and/or equipment off the top of the main(s).
- .7 Provide shut-off valves in piping at all equipment connections, to isolate piping components for removal or maintenance, and wherever else specified or shown. Provide vented type valves between air compressor set and pressure reducing stations.
- .8 Provide unions in piping at connections to equipment.
- .9 When piping is complete and has been pressure tested, but before connection of outlets, blowout piping to remove oil and foreign matter.
- .10 Provide adjustable pressure regulators, filters, compressed air outlets, etc. Unless otherwise indicated locate outlets 1.5 m (5 feet) above floor and properly secured in place. Provide a hose hanger at each outlet location. Confirm exact location of piping components prior to roughing-in.

3.3 SYSTEM STARTUP

- .1 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .2 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical. Submit a copy of the letter prior to Substantial Performance of the Work.

3.4 CLOSEOUT ACTIVITIES

- .1 Include for 4 hours of on-site training for 2 groups of 6 people. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 21 00 – Hydronic Piping and Pumps.

1.2 DESCRIPTION OF WORK

- .1 Supply and install a complete hydronic snow melting system consisting of (but not limited to) the following main components:
 - .1 A gas-fired heating plant including boilers, pumps, expansion tanks, glycol fill equipment and accessories serving snow melting system and floor radiant heating system;
 - .2 Snow melting embedded tubing;
 - .3 Piping distribution for the heating agent, including manifolds, valves, gauges and accessories;
 - .4 Valve and manifold concrete chambers;
 - .5 A digital control system to be tied into the Owner's building automation;
 - .6 Ancillary drainage, water make-up and accessories; and
 - .7 All power supply and control wiring required to make the system fully operational.
- .2 Complete design of the snow melting system, including calculation, layouts and schematic drawings to show control sequence, equipment layout, tubing patterns, manifold locations, appropriate cross-sections and special installation techniques to suit final architectural requirements and layout as required by code, standards and Authorities Having Jurisdiction.
- .3 Misinterpretation of any requirement of the drawings and specifications will not relieve the contractor of responsibility. If in any doubt, the contractor shall contact the Consultant for written clarification prior to submitting a bid for the Work.
- .4 Wherever differences occur between specifications, plans, schematics and drawings, the maximum conditions shall govern and the bid shall be based on whichever indicates the greater cost
- .5 In addition to the Work specifically mentioned in the Specifications and shown on the drawings, provide all other items that are obviously necessary to make a complete working installation, including those required by the Authorities Having Jurisdiction over the Work.

1.3 SUBMITTALS

- .1 Submit shop drawings and/or product data sheets for following:
 - .1 cross-linked polyethylene (PEX) floor heating grid tubing, fittings and accessories, manifold assembly, control components and controls;
 - .2 copies of system manufacturer's loop layout design printouts indicating water flows and temperatures, floor profiles with floor covering(s), and heating outputs;
 - .3 certified tubing and piping layout and schematic for each system zone;
 - .4 certified power wiring schematic and a certified control wiring schematic with sequence of operation for each system zone;
 - .5 letter from system component manufacturer stating system components proposed meet all requirements of the Specification.

- .2 Submit to the Consultant shop drawings, calculation and report for the snow melting system. Further details and special requirements called for in these specifications shall be shown on the shop drawings.
- .3 Submit Product data of all mechanical equipment including but not limit to:
 - .1 Boilers;
 - .2 Burners;
 - .3 Boiler Controls;
 - .4 Glycol automatic fill station;
 - .5 Expansion tank; and
 - .6 Pumps.
- .4 Provide mechanical layout and schematic drawing indicating heat source, mechanical piping and accessories from heat source to manifolds, circulators, water tempering and zone controls. Indicate primary loop and second loop's supply and return water temperatures and flow rates to manifolds.
- .5 Provide installation drawings indicating tubing layout, manifold locations, zoning requirements and manifold schedules with details required for installation of the snow melting system.
- .6 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly. Submit selection and verification samples of piping.
- .7 Provide control schematic drawing and detailed sequence of operation for snow melting system.
- .8 Provide samples of mechanical equipment as requested in the Specification at the same time as the shop drawing submission.
- .9 Ensure that copies of all reviewed shop drawings are available on the job site for reference.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit, prior to Substantial Performance of the Work, start-up or test data specified in Part 3 of this section.
- .2 Submit letters of installation certification from system manufacturer's representative as specified in Part 3 of this section.
- .3 Training attendance records.

1.5 AS-BUILT DRAWINGS

- .1 Maintain up to date "as built" drawings on site and submit to the Consultant at completion of the Project as specified in this Section
- .2 Any subsequent changes found by the Consultant shall remain the responsibility of the Contractor at no charge to the Owner.

1.6 QUALITY ASSURANCE

- .1 Radiant heating system is to be installed by journeyman tradesmen with a minimum of 3 years successful installation of PEX radiant floor system components supplied by manufacturer of components.

- .2 Prior to installation of system components, meet on-site with system component manufacturer's representative and trades whose work is related to successful installation of system(s) to confirm floor areas involved are ready for tubing installation.
- .3 Unless a written order reviewed by the Consultant and countersigned or otherwise approved by the Owner, no additional work shall be undertaken by the Contractor.

1.7 WARRANTY

- .1 Submit, at Substantial Performance of the Work, a non-prorated transferable repair or replacement warranty in name of Owner, issued by and signed by system component manufacturer covering materials against failure due to defects in material and/or workmanship as follows:
 - .1 PEX tubing, 25 years;
 - .2 manifold assemblies, 5 years;
 - .3 controls and electrical components, 2 years.
- .2 All tubes, supply lines, and return lines shall carry a twenty-five (25) year non-prorated warranty against failure due to defect in material and/or workmanship.
- .3 The complete system shall be covered by a two (2) year warranty against failure due to defect in materials and/or workmanship.
- .4 The complete system shall be covered by a ten (10) year limited system performance warranty. This warranty requires that the system detailed design, supervision, commissioning, and witnessing all pressure tests shall be performed by Authorized personnel employed by system supplier.
- .5 All warranty periods are measured from date of Substantial Performance of the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 Uponor Inc.;
- .2 Wirsbo;
- .3 Stadler

2.2 CROSSLINKED POLYETHYLENE TUBING

- .1 Cross-linked polyethylene (PEX) manufactured by the "Engle method". Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent third-party agency. Show compliance with ASTM E119 and ANSI/UL 263 through certification listings through UL.
- .2 Standard grade hydrostatic design and pressure ratings as issued by the Plastics Pipe Institute (PPI), a division of the Society of the Plastics Industry (SPI).
- .3 Minimum bend radius (cold bending) shall be no less than six times the outside diameter. Manufacturer's bend supports must be used if radius is less than stated.
- .4 Oxygen Diffusion Barrier:
 - .1 Not exceed an oxygen diffusion rate of 0.10 grams per cubic meter per day at 40°C (104°F) water temperature in accordance with German DIN 4726;

.2 Provide tubing with nominal inside diameter in accordance with ASTM F876, as indicated.

.1 12.7 mm ($\frac{1}{2}$ ").

.2 19 mm ($\frac{3}{4}$ ").

.3 25 mm (1").

2.3 HEATING AGENT DISTRIBUTION PIPING

- .1 All piping between the exterior wall of the boiler room and the interior wall of the distribution manifolds chamber(s) to be pre-insulated pipe system for buried commercial hydronic heating applications.
- .2 Pipes to be Cross linked polyethylene (PEX-a) Engel-method tubing with an EVOH oxygen barrier that conforms to German DIN 4726; smoothness value of 0.02 mil; NSF certified SDR-9.
- .3 Pipes insulated with Multilayered, closed-cell, PEX-foam insulation with a thermal conductivity of 0.26 BTU in./sq. ft./hour/°F; vapor permeability of 0.1g/100 sq. in./day
- .4 Cover jacket for insulated piping to be Corrugated seamless high-density polyethylene (HDPE), UV- protected.
- .5 Operating Limits:
 - .1 -50°C to 95°C (58°F to 203°F) at 87 psig.

2.4 MAIN HOT WATER PIPING AND FITTING

- .1 Exposed hot water heating piping inside the boiler room shall be standard black carbon steel schedule 40 to ASTM A-53. Up to 50 mm (2") threaded with 1,050 kPa (150 psi) malleable iron fittings, 65 mm (2 $\frac{1}{2}$ ") and up shall be welded, Victaulic grooved or flanged 150 psi welded.
- .2 All fittings, elbows, steel copper brass transitions, shrink caps, and miscellaneous items to be compression type and supplied by the pipe manufacturer.

2.5 MANIFOLDS (COMMERCIAL, VALVED COPPER)

- .1 Use 2" valved copper manifolds manufactured from Type L copper material, offered by the respective PEX tubing manufacturer. Valving shall include ball isolation valves.
- .2 Ensure manifold end cap offers tapping for $\frac{1}{8}$ " FNPT and $\frac{1}{2}$ " FNPT for vent and drain.
- .3 Install supply and return piping to the manifold in a reverse-return configuration to ensure self-balancing.
- .4 Use manifolds with an isolation valve on each outlet.
- .5 Use manifolds that support PEX tubing.
- .6 If the supply and return piping is in direct-return configuration, install and balance flow setters on the return leg of each manifold to the mains.

2.6 HEPEX SNOW MELTING TUBING

- .1 Section Includes: Hydronic snow and ice melting systems for various slab constructions and control strategies, using cross-linked polyethylene (PEX) tubing and applicable fittings.
- .2 Material: Cross-linked polyethylene (PEX) manufactured by the "Engle method".

- .3 Material Standard: Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent third-party agency
- .4 Pressure Ratings: Standard grade hydrostatic design and pressure ratings as issued by the Plastics Pipe Institute (PPI), a division of the Society of the Plastics Industry (SPI).
- .5 Show compliance with ASTM E119 and ANSI/UL 263 through certification listings through UL.
- .6 Minimum Bend Radius (Cold Bending): No less than six times the outside diameter. Use the PEX tubing manufacturer's bend supports if radius is less than stated.
- .7 Standard of Acceptance: Upnor, Wirsbo, Stadler or approved equivalent
- .8 Oxygen Diffusion Barrier:
 - .1 The oxygen diffusion barrier does not exceed an oxygen diffusion rate of 0.10 grams per cubic meter per day at 40°C (104°F) water temperature in accordance with German DIN 4726; and
 - .2 Nominal Inside Diameter: Provide tubing with nominal inside diameter in accordance with ASTM F876, as indicated.
 - .1 12.7 mm (½").
 - .2 19 mm (¾").
 - .3 25 mm (1").
- .9
- .10 Insulation:
 - .1 Use a 100 mm (4") rigid layer of Styrofoam insulation under the tubing ([per structural drawings](#))
- .11 Installer's Experience:
 - .1 The installing Contractor shall have a minimum of ten (10) years of demonstrated experience on projects of similar size and complexity in Ontario.
- .12 Glycol/Water Solution:
 - .1 The heating fluid shall be premixed glycol/water solutions. PEX tubing manufacturer allows site-mixed solutions if mixed to the proper concentration before entering the system.
 - .2 Mix the glycol/water solution to proper concentration levels to protect the system freezing during operation shutdown.
 - .3 System circulators must operate continuously for a minimum of thirty (30) days after the system is filled to ensure the glycol and water does not separate in a static system.
 - .4 Do not use ethylene glycol due to toxicity issues. Instead, use of propylene glycol. Also, refer to the boiler manufacturer's recommendations.
- .13 Field Quality Control:
 - .1 Site Tests:
 - .1 To ensure system integrity, pressure test the system before covering tubing in concrete or when other trades are working in the vicinity of the tubing.
 - .2 Test all electrical controls in accordance with respective installation manuals.
- .14 Cleaning:
 - .1 Remove temporary coverings and protection of adjacent work areas.

- .2 Repair or replace damaged installed products.
- .3 Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance.
- .4 Remove construction debris from project site and legally dispose of debris.
- .15 Demonstration:
 - .1 Demonstrate operation of hydronic snow and ice melting system to Owner's personnel.
 - .2 Advise the Owner about the type and concentration of glycol/water solution used in the hydronic snow and ice melting system.
 - .3 The Owner monitors the solution effectiveness through an established maintenance program as outlined by the glycol manufacturer.
- .16 Protection:
 - .1 Protect installed work from damage caused by subsequent construction activity.

2.7 FITTINGS

- .1 Use fittings, connectors, wall sleeves and other accessories offered by the PEX tubing manufacturer, including connectors to metallic piping
- .2 The fitting assembly must comply with ASTM F877 and CAN/CSA-B137.5 requirements
- .3 Fitting assembly manufactured from UNS C3600 series brass material.
- .4 Fitting assembly consists of a barbed insert, a compression ring and a compression nut. The barbed insert is manufactured with an o-ring to facilitate air pressure testing.
- .5 Fittings manufactured in accordance with ASTM F1960.
- .6 Fitting assembly manufactured from material listed in paragraph 5.1 of ASTM F1960.
- .7 The fitting assembly consists of a barbed adapter and an applicable sized PEX ring. The barbed insert may include an o-ring to facilitate pressure testing with air.

2.8 MANIFOLD CHAMBER

- .1 Pre-cast or poured in place concrete. Footprint and depth sized to avoid classification as "confined space". Coordinate with Structural Division.
- .2 Access doors
 - .1 Cover and frame to be constructed out of 6.35mm (1/4") aluminum. Cover to be checkered plate type, reinforced for 150 psf (732 kg/m²), live load. Frame to be extruded aluminum with built-in anchor flange around the perimeter.
 - .2 Continuous heavy-duty type 316 stainless steel hinges.
 - .3 Type 316 stainless steel slam lock latch with fixed interior handle and removable exterior turn/lift handle. Latch release is protected by a flush, gasketed, removable screw plug.
 - .4 Engineered composite compression spring operators enclosed in telescopic tubes. Automatic hold-open arm with grip handle release. Steel compression springs with electro coated acrylic finish
 - .5 Access doors to be finished with mill finish aluminum with a bituminous coating applied to the exterior of the frame.

2.9 GLYCOL AUTOMATIC FILL STATION

- .1 Install in accordance to the manufacturer's instruction. Provide concrete support pad.
- .2 Connect to power supply and controls; including tie-in to the Owner's building automation system.
- .3 Start-up and adjustment: by equipment manufacturer. Cost to be covered by the Contractor.

2.10 CONCRETE

- .1 All concrete work required to complete this Project, whether shown on the drawings or not, shall be the Contractor's responsibility.

2.11 METALS

- .1 All steel construction required for the completion of this Project, whether shown on the drawings or not, shall be the Contractor's responsibility.

2.12 CUTTING, PATCHING, ROOFING AND X-RAY

- .1 All cutting, patching, roofing and X-Rays required for the completion of this Project whether shown on the drawings or not, shall be the Contractor's responsibility. The cutting and patching work shall be performed in accordance with the following.

2.13 ACCESSORIES

- .1 Non-ferrous sleeves shall be provided wherever tubing enters and exits the floor.
- .2 Bend supports shall be provided for all 90° elbows.

2.14 VALVES

- .1 Asbestos packing is not acceptable
- .2 All valves of the same type shall be products of a single manufacturer. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.
- .3 Provide chain operators for valves 100 mm (4") and larger when the centerline is located 2,400 mm (8') or more above the floor or operating platform.
- .4 Standard of Acceptance: Crane, Jenkins, Toyo, Kitz or approved equivalent.
- .5 Gate Valves:
 - .1 50 mm (2") and smaller: MSS SP80, bronze, 1,034 kPa (150 lb.), wedge disc, rising stem, union bonnet.
 - .2 65 mm (2 ½") and larger: Flanged, outside screw and yoke.
 - .3 MSS SP 70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.
- .6 Globe, Angle and Swing Check Valves:
 - .1 50 mm (2") and smaller: MSS SP 80, bronze, 1034 kPa (150 lb.) Globe and angle valves shall be union bonnet with metal plug type disc.
 - .2 65 mm (2 ½") and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS SP 85 for globe valves and MSS SP 71 for check valves.

- .3 Non Slam or Silent Check Valve: Spring loaded double disc swing check or internally guided flat disc lift type check for bubble tight shut off. Provide where check valves are shown in chilled water and hot water piping.
- .4 Body: Cast iron, ASTM A126, Class B, or steel, ASTM A216, Class WCB, or ductile iron, ASTM 536, flanged, grooved, or wafer type.
- .5 Seat, disc and spring: 18-8 stainless steel, or bronze, ASTM B62. Seats may be elastomer material.
- .7 Butterfly Valves:
 - .1 May be used in lieu of gate valves. Provide stem extension to allow 50 mm (2") of pipe insulation without interfering with valve operation.
 - .2 MSS SP 67, flange lug type (for end of line service) or grooved end rated 1205 kPa (175 psig) working pressure at 93°C (200°F).
 - .3 Body: Cast iron, ASTM A126, Class B. Malleable iron, ASTM A47 electro-plated, or ductile iron, ASTM A536, Grade 65 45 12 electro-plated.
 - .4 Trim: Bronze, aluminum bronze, or 300 series stainless steel disc, bronze bearings, 316 stainless steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.
 - .5 Actuators: Field interchangeable. Valves for balancing service shall have adjustable memory stop to limit open position.
 - .6 Valves 150 mm (6") and smaller: Lever actuator with minimum of seven (7) locking positions, except where chain wheel is required.
 - .7 Valves 200 mm (8") and larger: Enclosed worm gear with handwheel, and where required, chain wheel operator.
- .8 Ball Valves:
 - .1 Brass or bronze body with chrome-plated ball with full port and Teflon seat at 2,760 kPa (400 psig) working pressure rating. Screwed or solder connections. Provide stem extension to allow operation without interfering with pipe insulation.
- .9 Water Flow Balancing Valves:
 - .1 For flow regulation and shut off. Valves shall be line size rather than reduced to control valve size and be one of the following types.
 - .2 Butterfly valve as specified herein with memory stop.
 - .3 Eccentric plug valve: Iron body, bronze or nickel plated iron plug, bronze bearings, adjustable memory stop, operating lever, rated 861 kPa (125 psig) and 121°C (250°F).
- .10 Circuit Setter Valve:
 - .1 A dual purpose flow balancing valve and adjustable flow meter, with bronze or cast iron body, calibrated position pointer, valved pressure taps or quick disconnects with integral check valves and preformed polyurethane insulating enclosure. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.
- .11 Automatic Balancing Control Valves:
 - .1 Factory calibrated to maintain constant flow ($\pm 5\%$) over system pressure fluctuations of at least ten (10) times the minimum required for control. Provide standard pressure taps and four sets of capacity charts. Valves shall be line size and be one of the following designs.

- .2 Gray iron (ASTM A126) or brass body rated 1205 kPa (175 psig) at 93°C (200°F), with stainless steel piston and spring.
- .3 Brass or ferrous body designed for 2067 kPa (300 psig) service at 121° C (250°F), with corrosion resistant, tamper proof, self-cleaning piston/spring assembly that is easily removable for inspection or replacement.
- .4 Brass or ferrous body designed for 2067 kPa (300 psig) service at 121°C (250°F), with corrosion resistant, tamper proof, self-cleaning piston/spring assembly that is easily removable for inspection or replacement.
- .5 Provide a readout kit including flow meter, probes, hoses, flow charts and carrying case.

PART 3 - EXECUTION

1.1 DESCRIPTION OF WORK

- ~~.1 Supply and install a complete hydronic snow melting system consisting of (but not limited to) the following main components:~~
 - ~~.1 A gas-fired heating plant including boilers, pumps, expansion tanks, glycol fill equipment and accessories serving snow melting system and floor radiant heating system;~~
 - ~~.1 Snow melting embedded tubing;~~
 - ~~.1 Piping distribution for the heating agent, including manifolds, valves, gauges and accessories;~~
 - ~~.1 Valve and manifold concrete chambers;~~
 - ~~.1 A digital control system to be tied into the Owner's building automation;~~
 - ~~.1 Ancillary drainage, water make up and accessories; and~~
 - ~~.1 All power supply and control wiring required to make the system fully operational.~~
- ~~.1 Complete design of the snow melting system, including calculation, layouts and schematic drawings to show control sequence, equipment layout, tubing patterns, manifold locations, appropriate cross sections and special installation techniques to suit final architectural requirements and layout as required by code, standards and Authorities Having Jurisdiction.~~
- ~~.1 Misinterpretation of any requirement of the drawings and specifications will not relieve the contractor of responsibility. If in any doubt, the contractor shall contact the Consultant for written clarification prior to submitting a bid for the Work.~~
- ~~.1 Wherever differences occur between specifications, plans, schematics and drawings, the maximum conditions shall govern and the bid shall be based on whichever indicates the greater cost.~~
- ~~.1 In addition to the Work specifically mentioned in the Specifications and shown on the drawings, provide all other items that are obviously necessary to make a complete working installation, including those required by the Authorities Having Jurisdiction over the Work.~~

3.1 INSTALLATION

- .1 Comply with manufacturer's product data, including product technical bulletins, installation instructions and design drawings.

- .2 Verify that site conditions are acceptable for installation of the snow melting system. Do not proceed with installation of the snow and ice melt system until unacceptable conditions are corrected.
- .3 Slab-on-grade Construction with Edge and Under-slab Insulation:
 - .1 When using high-density foam insulation board, install the tubing by [wire tie to rebar](#).
 - .2 The submitted snow-melt design shall specify the tubing on-center distance(s) and loop lengths, based on output and tubing diameter. On-center distances will not exceed 305 mm (12").
 - .3 Do not install tubing closer than 152 mm (6") from the edge of the heated slab.
 - .4 Install the tubing at a consistent depth below the surface elevation as determined by the Consultant. Tubing installation will ensure sufficient clearance for all control joint cuts.
 - .5 Fibrous expansion joints may be penetrated following the PEX tubing manufacturer's and structural engineer's recommendation.
 - .6 Metal or plastic bend supports will be used to support the tubing when departing from the slab in a 90° bend.
- .4 Ensure grid tubing has been successfully pressure tested prior to concealment. Be present when covering is being placed over grid tubing to ensure integrity of tubing is not compromised during placement of remainder of floor construction.
- .5 Heating Agent Distribution Piping:
 - .1 Piping shall be installed in a schedule 40 PVC pipe sleeve; the sleeve size shall be two diameter sizes larger than the combined diameter of the distribution piping plus insulation plus jacket.
 - .2 Maintain minimum 4" horizontal distance between the PVC sleeves.
 - .3 [Coordinate with the site services discipline the depth of the sleeves and the back-filling material, depending on the nature of the surface above \(landscape, pedestrian traffic, vehicular traffic, train right of way, etc.\).](#)
 - .4 [Respect the minimum bending radius recommended by the manufacturer.](#)
- .6 Where tubing and/or piping penetrates fire rated construction, provide firestopping in accordance with requirements specified in Section 20 05 17 – Sleeves and Sleeve Seals for Mechanical Piping.
- .7 Provide snow melt radiant heating zones and piping manifold assemblies. System installation is to be in strict accordance with manufacturer's instructions.
- .8 Provide a strainer in piping to manifold supply header and clean strainer screen when system balancing is to commence.
- .9 Prior to system flow balancing, ensure all air is purged from system and system operates successfully at design temperatures and pressure for a minimum of 2 days. Supply system manufacturer's software for final balancing flow adjustment settings.
- .10 Balancing Across the Manifold:
 - .1 Balance all loops across each manifold for equal flow resistance based on actual loop lengths and total **manifold** flow.
 - .2 Balancing is unnecessary when all loop lengths across the manifold are within 3% of each other in length. Install the supply and return piping to the manifold in a reverse-return configuration to ensure self-balancing.

- .3 Balancing between manifolds is accomplished with a flow control device installed on the return piping leg from each manifold when direct return piping is used for the supply and return mains.
- .4 Adjust all boiler and system controls after the system has stabilized to ensure proper operation in accordance with the system design.

3.2 SYSTEM STARTUP

- .1 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .2 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical. Ensure system manufacturer inspects grid tubing installation prior to concealment and certifies each zone correct in writing. Submit a copy of each certification letter prior to Substantial Performance of the Work.
- .3 After all equipment has been installed, adjusted, balanced and started up, subject equipment to a series of performance tests, as soon as conditions permit.
- .4 The timing of the tests shall be arranged to suit the convenience of the Consultant, and the manner and duration shall be as the Consultant deems necessary. Record the daily start and stop times, operating hours and functions performed. Ensure that the performance tests are witnessed by the Consultant.
- .5 All major equipment including but not limited to boilers, and pumps, are to be inspected by the manufacturer to ensure that the equipment has been installed in accordance with their recommendations.
- .6 Operate equipment under varying load conditions, demonstrate start-up sequence, normal shutdown, simulated emergency shutdown, operation of temperature, etc., and safety controls. Operate switches and electrical devices for correct wiring sequences. Adjust components to achieve a proper functional relationship among all the components of all the systems. Repeat these functions as many times as deemed necessary by the Consultant to achieve reliable operation.
- .7 Repair defects and repeat tests as necessary. During test maintain lubrication schedule, set, align and tension drives.
- .8 At the successful completion of Performance Tests and all testing and balancing, make the systems ready for final inspection and subsequent acceptance of the Owner. Replace and clean filters, flush out lines and equipment, remove and clean strainers, fill liquid systems and purge air as required by the codes. Disinfect all domestic water as required by current by-laws and Authorities Having Jurisdiction.

3.3 OPERATING AND MAINTENANCE MANUALS

- .1 Provide minimum of four (4) copies of Mechanical Maintenance Manuals. Mechanical Maintenance Manuals to be delivered to the Consultant's office ten (10) days prior to the Substantial Completion of the Contract.
- .2 Manuals to be bound in a hard cover neatly labeled: "OPERATING AND MAINTENANCE INSTRUCTIONS".
- .3 The Maintenance Manuals shall be divided into sections with neatly labeled and tabbed dividers between each section. The sections to be included in the manual and the information contained within each section are:
 - .1 Section I-General:

- .1 A list giving name, address and telephone number of the Consultant, Engineers, and Contractor, Mechanical Trade and Controls Trade.
- .2 Warranty certificates for the Mechanical Systems.
- .3 A copy of the valve directory giving number, valve location, normal valve position, and purpose of valve (a framed copy of valve directory to be hung in the boiler room).
- .4 Equipment lists and certificates shall be provided - certificates shall be signed and sealed by the appropriate suppliers.
- .2 Section II & III-Metallic piping and pump Systems, plumbing fixtures and snow and ice melting plastic tubing/In-floor radiant heating tubing:
 - .1 A copy of all pressure tests and operational tests, a copy of Gas Operational Tests for gas fired equipment. A list giving the name, address and telephone number of all suppliers. A copy of all reviewed shop drawings for the mechanical equipment.
- .3 Section IV-Automatic controls;
 - .1 Complete Control Diagrams, Wiring Diagrams and description of Control system and the functioning sequence of the system.
- .4 Section V-Hydronic Balancing Reports:
 - .1 Complete results of the hydronic balancing.

3.4 TESTING, ADJUSTING AND BALANCING (TAB)

- .1 Coordinate with the mechanical Contractor the TAB activity such that it does take place before the insulation is installed on ductwork and piping.
- .2 In the absence of such coordination, the mechanical contractor shall be responsible for the repair to the ductwork and or piping insulation removed for TAB purposes, including the integrity of the vapor barrier material and the insulation jacket.
- .3 General:
 - .1 Obtain applicable Contract Documents and copies of approved submittals for HVAC equipment and automatic control systems.
- .4 Systems Inspection Report:
 - .1 Inspect equipment and installation for conformance with design.
 - .2 The inspection and report is to be done after air distribution equipment is on site and duct installation has begun, but well in advance of performance testing and balancing work. The purpose of the inspection is to identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.
 - .3 Verify that all items such as ductwork piping, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the Consultant.
 - .4 Reports: Follow check list format developed by Associated Air Balance Council (AABC) or Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), supplemented by narrative comments
- .5 Tab Report:
 - .1 Format to be in accordance with referenced standard listed above, but using design drawing units.
 - .2 Produce "as-built" full system schematics. Use as-built drawings for reference.

- .3 Submit 1 copy of preliminary TAB reports, each in "D" ring binders, complete with index tabs for verification and approval of Consultant.
- .4 Submit copies of final TAB reports after approval by the Consultant, to be incorporated into the Maintenance and Operations Manual, as indicated in section 15010 General Mechanical Requirements.
- .6 Procedures:
 - .1 Tab shall be performed in accordance with the requirement of the Standard under which TAB agency is certified.
 - .2 Start final TAB only when building is essentially completed, including: normal operation of mechanical systems affecting TAB.
 - .3 General: During TAB all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work.
- .7 Water Balance and Equipment Test:
 - .1 Include all circulating pumps, heat exchangers, boilers, coils, chillers, coolers and condensers, as applicable to this Project.
 - .2 Adjust flow rates for equipment to the values indicated on the Contract Drawings and schedules. Set balancing valves and circuit setters to the values on indicated on the equipment schedules.
 - .3 Record final measurements for hydronic equipment on performance data sheets. Include entering and leaving water temperatures for heating and cooling coils, and for heat exchangers. Include entering and leaving air temperatures for all equipment (boilers, manifolds, mixing valves, etc).
- .8 Verification:
 - .1 Reported measurements shall be subject to verification by Consultant. Provide instrumentation and manpower to verify results of up to 30 % of all reported measurements. Number and location of verified measurements to be at discretion of Consultant.
 - .2 Bear costs to repeat TAB, as required, to satisfaction of Consultant.
- .9 Marking Of Settings:
 - .1 Following approval of TAB final Report, the setting of all HVAC adjustment devices including valves, splitters and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time. Style and colours used for markings shall be coordinated with the Consultant

3.5 DIGITAL CONTROLS

- .1 System Hardware:
 - .1 The system architecture will be comprised of PCUs (Primary Control Units), PACs (Programmable Application Controllers), ASCs (Application Specific Controllers) and any required communications or interface components networked together.
 - .2 All required site database and graphics files shall reside on the owner's central server. The connection between the central server and the BAS controllers (to be reserved for future) serving a specific building shall be through the WAN.

- .3 The building Staff shall be able to log into the local workstation, access and review on a read-only basis the graphical user interface showing the system layout and operational parameters.
- .4 The owner specialized trades shall be capable of accessing and modifying the parameters and schedules using direct connectors at the control panels and portable computers (laptops, notebooks, etc.).
- .5 Supply PCU's, PAC's and ASC's as required to interface to all specified equipment.
- .6 Allow for a minimum of 25% spare program and trend memory capacity in each PCU and PAC.
- .7 For each specified control point, the contractor shall supply the hardware point type (e.g. AI, AO, DI, DO) as indicated on the controls points list. The use of alternate hardware point types or the use of external interface cards or devices to simulate the function of a specified hardware point type is not acceptable. For example, the use of a DO point and an external PWM card to simulate the function of a physical AO point shall not be accepted.
- .2 Primary Control Units (PCU):
 - .1 Use only Primary Control Units to directly control any major mechanical equipment. Major mechanical equipment includes air handling units, boiler plants, chiller plants, cooling towers, roof-top units and other critical equipment.
 - .2 Each PCU shall contain a real time clock and sufficient memory to store its own application database, operating parameters, user programs and trend data storage.
 - .3 Battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of seventy-two (72) hours to eliminate operating data reload in case of power failure.
 - .4 Each PCU output shall include a Hand/Off/Auto (HOA) selector switch for each analog and digital output.
 - .5 Each PCU shall have a minimum of 10% spare capacity for each type of input and output channels and 10%.
- .3 Programmable Application Controllers (PAC):
 - .1 Programmable Application Controllers (PAC) are fully programmable controllers used for controlling distributed equipment including, but not limited to pumps, exhaust fans, VAV boxes, heat pumps, force flow units and unit ventilators.
 - .2 PACs shall not be used for controlling major mechanical equipment as described above.
 - .3 Each PAC shall contain a real time clock and sufficient RAM to store its own application database, operating parameters, user programs and trend data storage.
 - .4 Battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of seventy-two (72) hours to eliminate operating data reload in case of power failure.
- .4 System Software:
 - .1 Trend Data:
 - .1 Provide trend logs for all hardware inputs and outputs.
 - .2 All trends should be accessible via the graphical interface.

- .3 Trends should contain all related variables of a control loop (i.e. setpoint, measured variable and control output) and have the ability to be plotted simultaneously on the same graph.
- .4 Field Devices individual trends should provide an appropriate “snapshot” of the variable. Slow reacting variables such as space temperatures should be sampled every thirty (30) to sixty (60) minutes while other variables such as mixed air or boiler water temperatures should be sampled every five (5) to ten (10) minutes.
- .5 Provide the maximum number of trend samples within the controller while maintaining the requirement for spare memory capability.
- .6 The primary input sensor for all control loops must physically be wired to the same panel containing the control loop output (e.g. boiler water temperature and burner control output).
- .7 Trend data storage must be in the same panel as the hardware or logical points being trended.
- .5 User Access:
 - .1 Provide the Owner-standard user IDs and passwords for operations, maintenance and engineering staff.
- .6 Alarms:
 - .1 Alarms shall be assigned the following categories:
 - .1 Maintenance Alarms;
 - .2 Mismatch of equipment control and status for more than thirty (30) minutes; and
 - .3 Any other miscellaneous alarm not specifically noted herein.
 - .2 Alarms shall not require any acknowledgment before automatic reset by the system.
 - .3 An alarm notification shall not be issued when an alarm condition returns to normal.
 - .4 The Contractor shall provide additional alarms as directed by the Consultant and specified in this Section and customize the alarms to the operating characteristics of the specific the systems being controlled.
- .7 Dynamic Graphics:
 - .1 Provide customized, site specific dynamic graphics to meet the requirements of the Consultant and/or the Owner.
- .8 Sequence Of Operation:
 - .1 The heating plant shall serve the snow melting system and floor radiant heating system.
 - .2 The heating plant shall be enabled/disabled based on outdoor of temperature 12°C.
 - .3 The snow melting system shall be enabled/disabled based on outdoor air temperature 4°C.
 - .4 With the system enabled, the lead primary boiler pump shall start, while the lag pump shall be energized and in stand-by mode. The lead/lag status of the primary pumps shall alternate at one-hundred-sixty-eight (168) hour intervals (adjustable).
 - .5 Upon proof of flow in the primary loop, the boiler (B-3) shall start at minimum firing rate, while one of boilers (B-1 &2) shall be energized and another one shall be in stand-by mode. The lead/lag status of the boilers between B-1 & 2 shall alternate at 168 hour intervals (adjustable).

- .6 After the boiler starts, its firing rate shall modulate as required to maintain the primary loop return temperature at 52°C (125°F), and subject to a maximum primary loop supply temperature of 66°C (150°F).
- .7 If the boiler (B-3) fires at maximum rate for ten (10) minutes and cannot maintain the primary loop return temperature setpoint, another boiler shall start at minimum firing rate. If these two (2) boilers fire at maximum rate for ten (10) minutes and still cannot maintain the primary loop return temperature setpoint, the third boiler shall start at minimum firing rate, its burner shall ramp as required to achieve the maximum primary loop supply temperature of 66°C (150°F). The lead pump's capacity shall be changed by VFD panel to suit for the required water flow rate and pressure.
- .8 With the snow melting system enabled, the lead secondary snow melting loop pump shall start, while the lag pump shall be energized and in stand-by mode. The lead/lag status of the secondary snow melting loop pumps shall alternate at one hundred sixty-eight (168) hour intervals (adjustable).
- .9 With the floor radiant heating system enabled, the lead secondary pump shall start, while the lag pump shall be energized and in stand-by mode. The lead/lag status of the secondary snow melting loop pumps shall alternate at one hundred sixty-eight (168) hours intervals (adjustable), for detail refer to Section 15520 Hydronic Radiant Floor Heating System.
- .10 The four-way mixing valve shall modulate as required to maintain the snow- melting slab temperature at the following temperatures:
 - .1 0°C (+32°F) if no snow or ice is detected on the surface of the slab by the respective sensor
 - .2 +4°C (+40°F) if snow or ice is detected on the surface of the slab.
- .11 Additional settings for the operation of the 4-way mixing valve:
 - .1 Maintain the minimum primary loop return temperature of 52°C (125°F)
 - .2 Maintain the maximum temperature differential in the snow melting loop of 14°C (25°F) to prevent slab thermal shock.
- .12 The system shall generate alarms in case of:
 - .1 Any pump failure (while automatically enabling the stand-by pump).
 - .2 Any boiler failure (while automatically enabling the stand-by boiler).
 - .3 Primary loop temperatures 6°C (±10°F) departure from the setpoint.
 - .4 Slab temperature 3°C (±5°F) departure from the setpoint.
- .9 Installation of Snow Sensor:
 - .1 The installation of the snow sensor shall conform to the detail drawing.
 - .2 The contractor shall be responsible for the fabrication of the steel frame required to install the sensor at the prescribed elevation and maintain its position during the concrete pour.
 - .3 The installation procedure described on the detail drawing shall be followed accurately; at the conclusion of the installation work, a report shall be issued by the Contractor confirming that all installation steps have been followed and the installation of the sensor is in conformance with the detail.

- .4 Installation of all wiring and tubing in the area of the sensor shall be as indicated on the detail.
- .10 Installation Of Temperature Sensors In Piping:
 - .1 The Contractor shall ensure that thermowells are installed as described herein.
 - .2 For each immersion sensor, provide a compatible thermowell to the Mechanical Contractor for installation. Provide stainless steel thermowells where installed in piping carrying corrosive or chemically reactive fluids.
 - .3 Install thermowells in piping such that the bottom of the well does not make contact with the pipe. Install the well at a 90° elbow or tee where the pipe diameter is less than the well length.
- .11 Cutting And Patching:
 - .1 All cutting, patching, painting and making good for the installation of the work shall be done by the Contractor. All cutting shall be performed in a neat and true fashion, with proper tools and equipment
- .12 Identification And Labeling of Control Equipment:
 - .1 All panels must have a lamicaid tag (minimum 3"x1") affixed to the front face indicating panel designation and function (i.e. "Panel 1" or "Relay Panel 3").
 - .2 All field sensors or devices must have a lamicaid tag (minimum 3"x1") attached with tie-wrap or adhesive indicating the point software name and hardware address (i.e. AHU1_MAT, 2.IP4). Tags must be secured by screws where mounted outside of the building, in unheated spaces, in high humidity areas or where subject to vibration.
 - .3 All devices within a field enclosure shall be identified via a label or tag.
 - .4 All panel power sources must be identified by a label (minimum 3"x1") indicating the source power panel designation and circuit number (i.e. "120vac fed from LP-2A cct #1).
 - .5 All field control equipment panels fed from more than one power source must have a warning label on the front cover.
 - .6 All wires shall be identified with the hardware address with a band-type self-adhesive strips or clip-on plastic wire markers at both ends.
 - .7 All rotating equipment shall have a tag or label affixed indicating that the equipment may start without warning.
 - .8 All panels will be supplied with a point's list sheet (within a plastic sleeve) attached to the inside door.
 - .9 The points list shall identify the following for each point:
 - .1 Panel number;
 - .2 Panel location;
 - .3 Hardware address;
 - .4 Software name;
 - .5 Point description;
 - .6 Field device type;
 - .7 Point type (i.e. AI or DO);
 - .8 Device fail position;

- .9 Device manufacturer;
- .10 Model number or reference; and
- .11 Wire tag reference.
- .10 Provide laminated wiring diagrams for all field mounted relay enclosures. Securely attach to the inside door. Identify power panels and circuit numbers of the equipment being controlled.
- .11 Provide laminated wiring diagrams or modify existing equipment wiring diagrams. Securely attach to the inside of the respective control cabinet.
- .12 Provide lamcoid labels indicating the required operating sequences, on the boilers and valves, where the boiler plants have manual or automatic isolating valves. Submit actual wording to the Consultant for approval prior to fabrication and installation.
- .13 Provide lamcoid or machine labels (as outlined above) for all interposing relays or contactors used in control circuits. The labels shall include the related point software name and hardware address.
- .14 Provide a lamcoid label to identify the location of concealed devices above the ceiling space. Mount the label on the ceiling grid t-bar or a permanent surface adjacent to the devices.
- .15 Provide lamcoid labels for all auxiliary HVAC equipment (e.g. force flow cabinets, unit ventilators, unit heater, window AC units, etc.). Mount the labels in the vicinity of the existing thermostat or power switch for the unit.
- .16 Where directed by the Consultant, provide any and all additional labeling, diagrams, schematics or instructions as may be required to facilitate the correct operation and maintenance of controlled building systems.
- .13 Systems Hardware Commissioning
 - .1 The Contractor shall be responsible for the “end to end” commissioning, testing, verification and start-up of the complete control system hardware including panels, sensors, transducers, end devices, relays and wiring. Where applicable, this shall include any points from an existing and/or re-used automation system in the building.
 - .2 The Contractor shall prepare a hardware commissioning report containing the following information and test results:
 - .1 Analogue inputs (i.e. temperatures, pressure, etc.) shall be verified with an approved calibration device. All actual temperature readings should be with $\pm 1^{\circ}\text{C}$ of the readings observed at the workstation. Record calibration adjustments and settings.
 - .2 Analogue outputs shall be verified by manually commanding the output channel from the operator workstation to two or more positions within the 0-100% range and verifying the actual position of the actuator or device. All devices shall operate over their entire 0-100% range from a minimum control range of 10-90%. Record the actual output scale range (channel output voltage versus controller command) for each analogue end device.
 - .3 Digital outputs shall be verified by witnessing the actual start/stop operation of the equipment under control.
 - .4 Digital inputs shall be verified by witnessing the status of the input point as the equipment is manually cycled on and off.

- .5 Record all out-of-season or unverified points in the commissioning report as "non-commissioned".
 - .6 Identify any existing equipment (valves, dampers, fan starters, etc.) that are inoperative or require maintenance or repair.
 - .7 The panel power source shall be toggled on and off to ensure reboot functionality and power down memory retention of all parameters. During the power down test, all controlled system outputs shall go to their fail-safe position.
 - .8 Verify PID loop tuning parameters by applying a step change to the current setpoint and observing the response of the controlled device. Setpoint should be reached in an acceptable period of time without excessive cycling or hunting of the controlled device. Provide a graph of the trend response to setpoint change for important controlled devices (e.g. valves 1" or larger, dampers on major air handlers, etc.)
 - .9 Provide confirmation that a series of test alarms has been successfully received at designated remote monitoring workstations.
 - .10 Include with the hardware commissioning report a site floor plan indicating the location of all equipment installed in concealed or recessed locations (e.g. interposing relays in ceiling spaces).
 - .11 Provide testing of all LAN cabling to ensure that 100Mb bandwidth is supported.
 - .12 Verify conformance with TIA /EIA TSB-67 - Basic Link Test using a Level 2, bi-directional tester. Provide all equipment necessary to carry out the required tests.
 - .13 The hardware commissioning report must be signed and dated by the Contractor's technician performing the tests and participating Owner's trades staff.
 - .14 At the completion of site commissioning, submit four (4) copies of hardware commissioning report to the Owner.
- .14 Substantial Completion Inspection:
- .1 At the completion of the site hardware inspection, the Contractor shall test and verify that the system programming, graphics and alarm software is operating correctly and is in compliance all requirements of the Specifications.
 - .2 The Contractor shall provide written notification to the Owner that the site is ready for the Substantial Completion Inspection by the Consultant
 - .3 Issue a comprehensive site deficiency report to the Contractor for their immediate action.
 - .4 The Contractor shall correct all items noted in the site deficiency report within ten (10) business days of receipt.
 - .5 The Contractor shall provide written notification to the Owner that all items on the Consultant's site deficiency report have been corrected

3.6 SENSORS AND DEVICES

- .1 Snow Slab Sensor:
- .1 The snow/ice sensor and socket are used with the main controller to automatically detect snow or ice on a driveway or walkway. The snow/ice sensor socket must be installed directly in the snow melt slab, halfway between the heating elements or pipes.
 - .2 Sensor weight: 2,000 g (4.4 lb), silicon brass. 20 m (65 ft) jacketed cable

- .3 Socket weight: 830 g (1.8 lb), silicon brass
- .4 Dimensions (sensor): 45 x 80 x 80 mm (1¾" H x 3-1/8" W x 3-1/8" D)
- .5 Dimensions (socket): 96 x 89 x 89 mm D (3¾" H x 3½" W x 3½")
- .6 Operating range: -50 to 80°C (-60 to +175°F)
- .7 Sensor: NTC thermistor, 10 kΩ @ 25°C ±0.2°C (77°F), β=3892
- .8 Standard of Acceptance: Tekmar type 094 in socket type or approved equivalent.
- .2 In-Slab Sensor:
 - .1 Slab sensor has a PVC plastic sleeve which is designed for use in soils or concrete. The sensor is supplied with 40ft (12m) of 2 conductor cable.
 - .2 Packaged Weight: 0.7 lb. (320 g), PVC sleeve. 12 m ' (40) jacketed wire
 - .3 Dimensions: 13 o.d. x 51 mm (½" OD x 2")
 - .4 Operating range: -50 to 60°C (-60 to 140°F)
 - .5 Sensor-NTC thermistor, 10 kΩ @ 25°C ±0.2°C (77°F), β=3892
 - .6 Standard of Acceptance: Tekmar 073 or approved equivalent.
- .3 Outdoor Air Temperature Sensors:
 - .1 Provide outdoor air temperature sensors with the following minimum characteristics:
 - .2 Each sensor shall be a 6", 10K thermistor probe;
 - .3 Minimum two (2) sensors shall be installed for each site;
 - .4 Both sensors shall be mounted inside a heavy-duty (blow-proof) solar shield; and
 - .5 Provide a heavy-duty, metal, wire guard.
 - .6 Standard of Acceptance: Enercorp TS-O-T-10K, Honeywell, Johnson Controls or approved equivalent.
- .4 Immersion Temperature Sensors:
 - .1 Use immersion temperature sensors with thermowells for all applications where a temperature of a fluid in a pipe is being sensed.
 - .2 Provide well-mounted water temperature sensors with the following minimum characteristics:
 - .1 The sensors shall be 10k ohm thermistor encapsulated in a 6 mm o.d., 50 m long probe, with screw fitting for insertion into a standard thermowell;
 - .2 Operating range -10 to +100°C;
 - .3 End-to-end accuracy ± 0.3°C over the entire operating range;
 - .4 The sensors shall be complete with brass thermowell;
 - .5 Provide a stainless steel thermowell where exposed to corrosive liquids;
 - .6 Use conductive gel when mounting the sensor in the thermowell; and
 - .7 The sensors to be mounted on insulated piping shall be installed clear of the insulation.
 - .3 Standard of Acceptance: Enercorp TS-P-4-T-10K, Honeywell, Johnson Controls or approved equivalent.

- .5 Current Sensors (Analog):
 - .1 Current sensors (CT) shall be used for status monitoring of all motor-driven equipment, where specified.
 - .2 Technical Performance-Output should be only 4-20mA only. Voltage output will not be accepted. End-to-end accuracy $\pm 1\%$ of full scale at each range.
 - .3 The current sensors shall be mounted inside the starter cabinets whenever possible. If this is not possible due to space limitation, provide an enclosure to house the sensor.
 - .4 Standard of Acceptance: Enercorp SA200, Honeywell, Johnson Controls or approved equivalent.
- .6 Automatic Control Valve Actuators:
 - .1 Each automatic control valve shall be fitted with a "fail-safe" operator capable of tight shut-off against the differential imposed by the system.
 - .2 Operators for valves in electric-electronic control systems shall be single phase
 - .3 AC, 24V electric motor operators.
 - .4 Valve actuators on valves 3" diameter and larger shall be provided with a manual position override.
 - .5 Valve actuators shall accept a 0-10VDC or 4-20mA control signal for all proportional applications
 - .6 Floating point control of valves is not acceptable under any circumstances.
 - .7 Installed by the Contractor, unless specified otherwise.
 - .8 Each control valve shall be equipped with its own actuator.
 - .9 The Contractor shall ensure that each control valve assembly is properly connected and installed.
 - .10 The Contractor shall test, adjust and verify the operation of each control valve to ensure that it is properly functioning, as required and left in safe working order.
- .7 Local Service Ports:
 - .1 Every DDC panel shall be provided with a local network access port to connect to laptop computer. A user connected to the local access port shall have the same level of system access and functionality as being connected to the networked Owner's workstation
 - .2 Where points (four (4) or more) are located in a mechanical room that does not have a local panel installed, a remote network access port shall be provided. The access port shall be installed in a hinged metal enclosure with key-lock set and lamicoid ID label.
- .8 LAN Cabling:
 - .1 All LAN cabling shall be Category V as defined by EIA/TIA 568A. The Contractor shall test all cabling to verify that 100Mb bandwidth is supported. See commissioning requirements.
 - .2 Cabling shall be four (4) pair, 100 Ω UTP, #24 AWG solid copper conductor PVC insulated, with blue or grey colour coded jacket. FT6 rated cable shall be used unless otherwise required to meet building codes or by-laws.
 - .3 Data outlets shall be RJ45, eight (8) pin connectors, with 50 microns of hard gold over nickel, minimum durability of 750 mating cycles and contact pressure of 100 grams per contact. Transmission characteristics shall meet TSB-40 Category V.

- .4 Provide one RJ45 data outlet adjacent to each device to be terminated (e.g. workstation PC, DDC panel, hub, etc.) Use a flexible patch cable to connect from the data outlet to the end device.
- .5 Provide protection from EMI sources in accordance with CAN/CSA-T530 article 4.
- .6 The contractor shall test all cabling to verify conformance with TIA/EIA TSB-67 Basic Link Test using a Level 2, bi-directional tester. See commissioning requirements.
- .7 Where there are more than 2-90° in a conduit run, provide a pull box between sections so that there are two (2) bends or less in any one (1) section.
- .8 Where a conduit run requires a reverse bend, between 100° and 180°, insert a pull box at each bend having an angle from 100° to 180°.
- .9 Ream all conduit ends and install insulated bushings on each end. Terminate all conduits that protrude through the structural floor 2" above the concrete base. Do not use a pull box in lieu of a conduit bend. Align conduits that enter a pull box from opposite ends with each other.
- .9 Automatic Control Valves:
 - .1 Automatic control valves shall be supplied by the Controls Contractor and installed by the Mechanical Contractor.
 - .2 Automatic control valves, unless otherwise specified, shall be globe type valves.
 - .3 Valves and actuators shall be ordered as one factory-assembled and tested unit.
 - .4 Submit to the Consultant for review, a valve schedule containing the following information for each valve:
 - .1 Valve type and size;
 - .2 Connection type;
 - .3 Line size;
 - .4 Valve manufacturer and model number;
 - .5 Valve flow coefficient;
 - .6 Design flow;
 - .7 Pressure drop across valve;
 - .8 Maximum close-off pressure;
 - .9 Actuator manufacturer and model number; and
 - .10 Actuator maximum torque.
 - .5 Valves 50 mm (2") and smaller shall be constructed of bronze. Valves 65 mm (2½") and larger shall have iron bodies and bronze mountings.
 - .6 All control valves shall have stainless steel stems.
 - .7 The bronze in bodies and bonnets of all bronze valves shall conform to ASTM B62 for valves rated up to 150psig (1,035 Kpa) working pressure and to ASTM B61 for valves rated at 200 psig (1,380 Kpa) working pressure.
 - .8 The bodies and bonnets of iron body valves shall conform to ASTM A126, Class B.
 - .9 Control valve discs and seats shall be of bronze for 100°C or less fluid temperature and of stainless steel for fluid temperatures above 100 °C.

- .10 The control valves shall have tight shut-off. Flat disk valves are not acceptable.
- .11 Control valves 50 mm (2") and smaller shall be complete with screwed ends type, except for bronze valves installed in soldered copper piping which shall be complete with soldering ends. Control valves larger than 50 mm (2") shall be complete with flanged end type and proper flanged adapters to copper shall be provided where flanged valves are installed in copper piping.
- .12 The water control valves shall be sized for a pressure drop of 6 ft. water column or as indicated on mechanical drawings.
- .13 Each automatic control valve must provide the design output and flow rates at pressure drops compatible with equipment selected.
- .14 Each automatic control valve must be suitable for the particular system working pressure.
- .15 Each automatic control valve shall be fitted with a position indicator.
- .16 All the same type control valves shall be the products of a single manufacturer and have the manufacturer's name, pressure rating and size clearly marked on the outside of the body.
- .17 Unless otherwise indicated, control valves for proportional operation shall have equal percentage characteristics, while the control valves for open/shut two- position operation shall have straight line flow characteristics.
- .18 Standard of Acceptance:
 - .1 Siemens.
 - .2 Danfoss.
 - .3 Honeywell.
 - .4 Or approved equivalent.

3.7 TRAINING

- .1 Include for 4 hours of on-site training for 2 groups of 6 people. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.
- .2 Prior to providing training perform system demonstration as per requirements of Section 01800 Project Closeout.
- .3 Supply certified personnel to instruct the Owner on operation of new mechanical equipment. Supply maintenance specialist personnel to instruct operating staff on maintenance and adjustment of mechanical equipment and any changes or modification in equipment made under terms of warranty.
- .4 Provide minimum four (4) hours of instruction time during regular work hours prior to acceptance and turn-over to operating staff for regular operation.
- .5 Use operation and maintenance data manual for instruction purposes. On completion of instruction, turn manuals over to the Consultant.
- .6 Scheduling of the timing for the training of the operating staff shall be arranged with the Consultant ten (10) days prior to the completion of the Project.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 ANSI/IEEE C12.20 – American National Standard for Electricity Meters
- .2 NEMA C12.1 – Electric Meters; Code for Electricity Metering.
- .3 IEEE C57.13 – Standard Requirements for Instrument Transformers
- .4 Ontario Electrical Safety Code c/w Bulletins and Amendments.
- .5 Ontario Building Code and its referenced standards.
- .6 Underwriters Laboratories UL 1283 and UL 1449 (most recent edition).
- .7 Canadian Standards (cUL or cETL).

1.2 SCOPE

- .1 Install and commission a power monitoring, analysis and control system that employs computer technologies to provide a robust, reliable, and secure data network.
- .2 The system shall be complete with web-enabled Power Monitoring and Control (PMAC) software package intended to monitor the entire data centre electrical distribution infrastructure.
- .3 The system shall be designed to monitor and manage energy consumption throughout an enterprise, to improve energy availability and reliability, and manage and measure energy efficiency.

1.3 SUBMITTALS

- .1 Shop Drawings:
 - .1 Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - .2 Include devices, locations, connections, conduit runs, wiring type, details, and attachments to other work.
- .2 Product Data: Provide dimensions, ratings, and performance data.
- .3 Submit manuals, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts.
 - .1 Wiring diagrams shall have their terminals identified to facilitate installation, maintenance, and operation.
 - .2 Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnection between the items of equipment.
 - .3 Provide a clear and concise description of operation, which gives, in detail, the information required to properly operate the equipment.
 - .4 Approvals will be based on complete submissions of manuals together with shop drawings.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit manufacturer's operation and maintenance instructions for each product.
- .2 Software installation CD's, etc.

- .3 Manuals:
 - .1 The manuals submitted for review shall be updated to include any information necessitated by shop drawing approval.
 - .2 Complete "As Installed" wiring and schematic diagrams shall be included which show all items of equipment and their interconnecting wiring.
 - .3 Show all terminal identification.
 - .4 Include information for testing, repair, troubleshooting, assembly, disassembly, and recommended maintenance intervals.
 - .5 Provide a replacement part list with current prices. Include a list of recommended spare spares, tools, and instruments for testing and maintenance purposes.
- .4 Certification by the contractor that assemblies have been properly installed, adjusted, and tested.
- .5 Certified copies of all factor design and production tests, and field test data sheets and reports for the assemblies.

1.5 SUMMARY

- .1 The specifications in this section describe the performance, furnishing, installation and connection of a digital electric metering system installed on electrical equipment such as low voltage switchboards, distribution panels and/or low voltage branch circuit panelboards of the power system. The specified system shall provide effective revenue quality metering of the loads indicated on the single line diagram. The system shall be accessible either at the meter(s) located in the data centre, or remotely by computer.

1.6 ENVIRONMENTAL REQUIREMENTS

- .1 The operating temperature range shall be -40°C to 70°C (-40°F to 160°F).

1.7 QUALITY ASSURANCE AND WARRANTY

- .1 The meter and supporting components shall be guaranteed by the manufacturer to be free of defects in material and workmanship for a period of three (3) years from the date of substantial completion of service and activation of the system to which the meter(s) are attached.
- .2 Warranty service may be performed by the manufacturer or authorized representative.
- .3 The contractor shall support the system for two years after commissioning.

1.8 MANUFACTURER QUALIFICATIONS

- .1 The meter shall be manufactured by a manufacturer that has been regularly engaged in the design, manufacturing and testing of digital meters of the types and ratings required for a period of not less than five years. Manufacturers requesting product approval must meet or exceed the written specification contained herein. Manufacturers requesting approval must receive written verification of product acceptance by the specifying engineer 10 days prior to the bid date.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 The Digital Power Instrumentation Package shall be a complete system from one of the following:
 - .1 The Digital Power Instrumentation Package shall be a 7330 ION series as Manufactured by Power Measurement Limited.
 - .1 Model P7330R0B0B0E0A0A or approved equal.
 - .2 The PMAC Software shall be ION Enterprise V6.0 or latest version with a 10 device license as manufactured by Power Measurement Ltd.
 - .2 Eaton.
 - .3 Intellimeter
 - .4 Siemens.
 - .5 Electro Industries/GaugeTech.

2.2 REGULATORY REQUIREMENTS

- .1 Products: Listed and classified by CSA (Canadian Standards Association), ULC (Underwriters' Laboratories of Canada), or CUL.

2.3 INSTRUMENT TRANSFORMERS

- .1 General
 - .1 Mount and brace transformers to withstand 100,000 A short circuit current.
 - .2 Install in feasible location near upstream overcurrent device.
 - .3 Meters shall be revenue grade.
- .2 Current Transformers (CTs)
 - .1 ANSI C57.13; 5 A secondary, with primary/secondary ratio as shown on drawings, to suit size of associated upstream overcurrent devices.
 - .2 All Current Transformers shall be split-core type with 80 mA secondary unless noted otherwise.
 - .1 Provide donut or square type to suit cable or bus, respectively.
 - .3 CTs shall be Measurement Canada type approved or have a minimum accuracy of 0.3%.
 - .4 One CT is required for each phase being metered.
- .3 Potential Transformers (PTs).
 - .1 ANSI C57.13, 120 V secondary.
 - .2 Burden and accuracy consistent with connected metering and relay devices, 60 Hz.
 - .3 Potential transformers are required for metering an all electrical systems above 120/208 V.
 - .4 Potential transformers on 347/600 V systems shall be rated 347-120 V, connected phase-to-neutral, and installed on each phase.
 - .5 PTs shall be wired line-neutral for Wye systems and line-line for delta systems.

- .6 CTs shall be Measurement Canada type approved or have a minimum accuracy of 0.3%.
- .7 Meter shall not be powered from the PT secondary.
- .8 Voltage inputs shall be fed from a dedicated 15 A breaker in distribution panel where practical.
- .9 Supply and install appropriate 1 A fuses.

2.4 DIGITAL POWER INSTRUMENTATION PACKAGE

- .1 The Digital Power Instrumentation Package shall be a true RMS, bi-directional, four quadrant meter capable of measuring, calculating and directly displaying on the front panel display the following information in user programmable groups.
 - .1 Voltage.
 - .2 Current.
 - .3 kW.
 - .4 kVAR.
 - .5 kVA Power Factor.
 - .6 Harmonics.
 - .7 Demand.
 - .8 minimums and maximums for each phase.
 - .9 minimum and maximum totals for all phases.
 - .10 KWh, kVARh, kVAh totals for all phases.
 - .11 Voltage and current unbalance.
 - .12 Frequency.
 - .13 k-factor.
 - .14 Harmonic distortion for each voltage and current input, up to the 15th harmonic.
- .2 The Digital Power Instrumentation Package shall:
 - .1 Perform continuous true RMS measurement based on 32 samples-per-cycle sampling on all voltage and current signals. Readings shall be updated once per second.
 - .2 Retain all setup data in non-volatile memory (NVRAM).
 - .3 The PMAC Instrument shall include 512 kB of non-volatile memory with two fully programmable 16-channel data recorders.
 - .4 The PMAC instrument shall support multiport communications that provides two ports for RS-485 communications. Interface via ION, DNP3.0, Modbus TCP, and Modbus RTU protocols, through serial or Ethernet communications.
 - .5 Include 10BaseT Ethernet communications port and Ethergate networking capabilities.
 - .6 Have an on-board WebMeter.
 - .7 The PMAC Instrument shall provide setpoint control to four digital output relays.
 - .8 Meet the following standards:
 - .1 Measurement Canada Revenue approved.
 - .2 Certified to CAN/CSA-C22.2 No.1010-1.

- .3 All inputs pass ANSI/IEEE C37.90-1989 surge withstand and fast transient tests.
- .4 Manufactured under ISO 9002 Quality Assurance Standard.
- .3 The Digital Power Instrumentation Package shall:
 - .1 Require no PTs on voltage inputs Wye (Star) for 120/208/240 V systems. PTs can be used on higher voltage systems.
 - .2 Must meet all ISO 9001 standards for quality control where all meters test to a minimum of +/-0.5% accuracy.
 - .3 The current transformers shall have a full scale output of 330 mV (split core), 80 mA (solid core donut) or 5 A (solid core or split-core donut) outputs for safety purposes.
 - .4 Meters to be complete with a Liquid Crystal Display (LCD) to access all energy measurements and phase diagnostics when needed.
 - .5 Meter to have backup storage power so no data is lost during power outages. Device must be capable of holding 2 years of interval data for a 20 year period. The system shall continue to function after resumption of power.
 - .6 Failure of the building electrical normal power system shall not result in loss of data and will not require manual restarting of the metering system.

2.5 METER ENCLOSURES

- .1 The digital meters shall be installed in pre-wired, NEMA 12, CSA approved enclosures.
 - .1 Multiple meters shall be installed in the same enclosure.
 - .2 Meters supplied from two different switchboards or different sources cannot be installed in the same enclosure.
 - .3 Meters shall be wired according to manufacturer's recommended method.
 - .4 Each meter shall be labeled.

2.6 COMMUNICATIONS AND NETWORKING COMPONENTS

- .1 RS485 communications for all meters shall be terminated in the enclosure according to manufacturer's recommended practice.
- .2 To enable the meters to communicate to the central monitoring software, a Lantronix UDS10 or equivalent RS485 to Ethernet serial server shall be provided in each enclosure.
- .3 Routers or other required networking components shall be provided according to Owner's standard.
- .4 The electrical contractor shall be responsible for providing all metering communication wiring between the meters and shall provide a single Ethernet communication point from the meters(s) to the data centre infrastructure patch panel. All Ethernet wiring shall be minimum Category 6A CMP rated. Ethernet wiring shall be installed in EMT conduit.
- .5 Coordinate with Division 27.

2.7 POWER MEASUREMENT AND CONTROL (PMAC), MONITORING AND REPORTING SOFTWARE

- .1 Supply and install all software to be installed on one server as directed by the Owner.

- .2 The metering system shall interface with a computing server component: Windows 7 operating system, 1 RU or 2 RU server, rack mountable form factor.
- .3 Hardware shall meet the Software manufacturer's recommended requirements.
- .4 Install and commission a power monitoring, analysis and control system that employs the latest computer technologies to provide a robust, reliable, and secure data network.
- .5 The PMAC Enterprise software shall have the following functionality:
 - .1 Server Workstations shall be used for connection to PMAC instruments located at monitoring as recommended by the manufacturer.
 - .1 Workstations shall have minimum hardware features as recommended by the manufacturer.
 - .2 The Communications Server shall support communication between software components and IEDs with an arbitrary number of IEDs, multiple concurrent serial and Ethernet communications links.
 - .3 Require no proprietary network communication hardware.
 - .4 Support automatic alarm call-back for any IED equipped with this capability.
 - .5 Support any combination of the following communication protocols directly to IEDs: ION; Modbus RTU; Modbus TCP; Serial or TCP/IP.
 - .2 Data Storage and Data Sharing
 - .1 The PMAC software shall support an arbitrary number of Windows-based Server Workstations, each running log acquisition software (Log Server) that provides the ability to:
 - .1 Autonomously retrieve, from any or all IEDs in the PMAC network, log records of the following type:
 - .1 Event log records containing device event information.
 - .2 Historical log records containing numerical and Boolean data.
 - .3 Historical log records containing waveform data.
 - .2 Dynamically manage database tables to reflect changes in the configuration of any IED's waveform log or data log, with no need to shutdown and restart any software.
 - .3 Report the occurrence of events to all user interface software components that are in use for event and alarm indication. To ensure fast event annunciation, all event information shall be made available to the user interface software and the database software concurrently.
 - .2 The PMAC software shall include a database management component that provides the ability to:
 - .1 Selectively remove a range of records from the database
 - .2 Archive database files on magnetic tape or other buyer-approved off-line storage media.
 - .3 Use the MS SQL Server database software as the database engine. If the license is less than 10 nodes the MSDE database that is included with the

software can be used. If there are more than 10 nodes communicating with the PMAC, then MS SQL Server DB license must be included.

.3 Integrated Object Processing Software

- .1 The PMAC software shall support an arbitrary number of Windows-based Server Workstations, each running an Integrated Object Processing software component.
- .2 The Integrated Object Processing software can be used to autonomously collate information (objects) that has been acquired from multiple sources, using diverse protocols, and allows the information to be processed for user-defined analysis and logging purposes. The Integrated Object Processing software shall be ION-compliant.
- .3 The software license shall be purchased to accommodate all nodes with communications to the software, plus an additional 10% nodes shall be included for future addition.

.4 User Interface

- .1 The PMAC software shall support an arbitrary number of each of the following types of Graphical User Interface components:
 - .2 User Display software.
 - .3 Device Configuration software.
 - .4 Network Configuration software.
 - .5 WebReach Browser based viewer using IIS.
- .6 The User Display component shall provide the graphical interface to power monitoring, analysis, and control functions through an arbitrary number of user diagrams.
- .7 There shall be a summary screen of the electrical single line diagram showing all energy monitoring nodes in real-time on the same screen, with drill-down icons for more detailed real-time data on each node. If it is not practical to show all nodes on one screen, multiple screens can be developed.

.5 Reports.

- .1 The PMAC software shall include a report generation tool written in Visual Basic Macros using MS Excel spreadsheets. The reports must allow for cost allocation, load aggregation and power quality.
- .2 The number and type of reports and will be defined by the owner before commissioning.
- .3 The software shall have the provision to include IMO real time pricing and shadow billing functionality that matches with the local utility billing structure to create accurate bills for comparison and verification. The future shadow billing package shall also support tenant billing or cost allocation based on the IMO real-time price structure and local utility rates.

2.8 LOCATIONS OF METERING DEVICES

- .1 Locate as shown on Drawings and as recommended by Manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 All power supply and communications wiring connections shall be performed in accordance with the guidelines set out in the product documentation.
- .2 The meters shall be mounted in the locations indicated.
- .3 All unused openings shall be covered with a metal closure plate painted to match the existing enclosure.
- .4 Any extension of wiring needed to accommodate the meters shall be done using terminal blocks and 10 AWG stranded copper wire, 600 V type SIS insulation. Splices are not allowed.
- .5 Dangerous voltage will develop in the open circuit secondary windings of energized current transformers. De-energize the current transformers by short circuiting the secondary windings before disconnecting or connecting instruments to current transformers.
- .6 Verify the proper operation of all meters. Compare the meter display readings to measurements taken with a clamp on amp-meter and handheld volt meter.
- .7 This contractor shall provide all communication trunk wiring to provide for a single connection point to the data centre LAN.
- .8 All communications networking equipment, including hubs, routers, etc. required to enable a single connection to the owner's IT infrastructure shall be provided by this contractor. Provide local circuit from UPS source.
- .9 Communications networking shall be tested and proved to be working before acceptance.
- .10 All voltage sending connections to PMAC instrumentation shall be made with 2 A fuses.
- .11 Appropriately sized current transformers must be installed on each phase and must be installed with CT shorting blocks.
- .12 Meters must be powered from an auxiliary power supply, and not powered from the PTs.
- .13 The installation must be in accordance with the Ontario Electrical Safety Code.
- .14 The contractor is responsible for ensuring pulse inputs are wired properly to the meter.

3.2 COMMISSIONING AND CONSTRUCTION VERIFICATION

- .1 Contractor is responsible for utilizing construction verification checklists supplied under commissioning section.

3.3 SOFTWARE CONFIGURATION

- .1 Contractor shall ensure the software is properly configured and communicating to all meters and related devices specified and as noted on the drawings.
- .2 Provide system configuration documentation that can be used for an emergency recovery.

3.4 TRAINING

- .1 The contractor shall conduct a training course for meter configuration, operation, and maintenance of the system as specified. The training shall be oriented for all components and systems installed under this contract. The training shall include:
 - .1 Physical layout of each piece of hardware.

- .2 Meter configuration, troubleshooting and diagnostic procedures.
- .3 Repair instructions.
- .4 Preventative maintenance procedures and schedules.
- .5 Testing and calibration procedures.
- .6 Use of metering software.
- .2 Contractor shall include hands-on training with a factory trained representative or local integrator to ensure the end user is comfortable with the software. Schedule training during normal business hours.

END OF SECTION