

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

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PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

1.2 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.

1.3 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.

1.4 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.

1.5 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.

1.6 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/MATERIALS

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 (½").
 - .2 19 mm (¾").
 - .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 ½") 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 and balancing valves.
- .2 Ensure manifold end cap offers tapping for 1/8" FNPT and 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 or a combination isolation and balancing 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 (1/2").
 - .2 19 mm (3/4").
 - .3 25 mm (1").
- .9 Heating Agent Distribution Piping:
 - .1 Section Includes: all piping between the exterior wall of the boiler room and the interior wall of the distribution manifolds chamber(s).
 - .2 System Description:

- .1 Pre-insulated pipe system for buried commercial hydronic heating applications; and
- .2 Service pipes are made from durable "Engel-method" crosslinked polyethylene (PEX-a) tubing and protected by multilayer PEX-foam insulation and covered by a corrugated, waterproof HDPE jacket. The system can use Uponor ProPEX® fittings or WIPEX™ dezincification- resistant (DZR) brass compression fittings or approved equivalent. Saline and electronic cross linking methods are not acceptable.
- .3 Service Pipe:
 - .1 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.
- .4 Insulation:
 - .1 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
- .5 Jacket Corrugated seamless high-density polyethylene (HDPE), UV-protected.
- .6 Operating Limits:
 - .1 -50°C to 95°C (58°F to 203°F) at 87 psig.
- .7 Standard of Acceptance: Ecoflex or approved equivalent.
- .10 Manufacturer's Instructions:
 - .1 Comply with manufacturer's product data, including product technical bulletins, installation instructions and design drawings.
- .11 Insulation:
 - .1 Use a 50 mm (2") rigid layer of Styrofoam insulation under the tubing.
- .12 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.
- .13 Examination:
 - .1 Verify that site conditions are acceptable for installation of the snow melting system.
 - .2 Do not proceed with installation of the snow and ice melt system until unacceptable conditions are corrected.
- .14 Installation:
 - .1 Slab-on-grade Construction with Edge and Under-slab Insulation:
 - .1 When using high-density foam insulation board, install the tubing by stapling the tubing to the insulation board with Uponor Foam Staples or approved equivalent.
 - .2 The under-slab insulation shall be rigid 2" polystyrene suitable for underground applications.

- .3 Install the vertical edge insulation along the perimeter of the slab and down to a depth equal to the bottom of the horizontal under-slab insulation.
- .4 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").
- .5 On a 24" wide band along the platform edge, the piping density shall be increased to the maximum allowed by the manufacturer (6" on centre) regardless of the size of the tubing.
- .6 Do not install tubing closer than 152 mm (6") from the edge of the heated slab.
- .7 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.
- .8 In areas where tubing must cross metal expansion joints that occur in the concrete, the tubing shall pass below the metal expansion joints.
- .9 Fibrous expansion joints may be penetrated following the PEX tubing manufacturer's and structural engineer's recommendation.
- .10 Metal or plastic bend supports will be used to support the tubing when departing from the slab in a 90° bend.
- .15 Asphalt Construction with Edge and Under-slab Insulation:
 - .1 When using high-density foam insulation board, install the tubing by stapling the tubing to the insulation board with Uponor Foam Staples or approved equivalent.
 - .2 The under-slab insulation shall be rigid 2" polystyrene suitable for underground applications.
 - .3 Install the vertical edge insulation along the perimeter of the slab and down to a depth equal to the bottom of the horizontal under-slab insulation.
 - .4 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 229 mm (9").
 - .5 On a 24" wide band along the platform edge, the piping density shall be increased to the maximum allowed by the manufacturer (6" on centre) regardless of the size of the tubing.
 - .6 Do not install tubing closer than 152 mm (6") from the edge of the heated slab.
 - .7 Bedding material for all tubing shall be layer minimum 6" deep of compacted #8 crushed limestone and screenings (3/8" dia.). The fill over the PEX tubing must be void of any sharp material. The pavers are then installed over the compacted soil bed.
 - .8 Backfilling of all pipe shall be well compacted by means of jetting or other approved methods to eliminate settling. Any completed areas that show settlement shall be promptly re-backfilled with compacted clean earth
 - .9 Metal or plastic bend supports will be used to support the tubing when departing from the slab in a 90° bend.
- .16 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.

.17 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.

.18 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.

.19 Adjusting:

.1 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.

.20 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.

.21 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.

.22 Protection:

.1 Protect installed work from damage caused by subsequent construction activity.
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.
- .3 Where insulation is required, this Contract shall supply and install in accordance with the manufacturer's requirements, and as noted herein.

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 1/2") 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

3.1 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;
 - .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.

3.2 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 stapling the tubing to the insulation board with Uponor Foam Staples or approved equivalent.
 - .2 The under-slab insulation shall be rigid 2" polystyrene suitable for underground applications.
 - .3 Install the vertical edge insulation along the perimeter of the slab and down to a depth equal to the bottom of the horizontal under-slab insulation.
 - .4 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").
 - .5 On a 24" wide band along the platform edge, the piping density shall be increased to the maximum allowed by the manufacturer (6" on centre) regardless of the size of the tubing.
 - .6 Do not install tubing closer than 152 mm (6") from the edge of the heated slab.
 - .7 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.
 - .8 In areas where tubing must cross metal expansion joints that occur in the concrete, the tubing shall pass below the metal expansion joints.
 - .9 Fibrous expansion joints may be penetrated following the PEX tubing manufacturer's and structural engineer's recommendation.
 - .10 Metal or plastic bend supports will be used to support the tubing when departing from the slab in a 90° bend.
- .4 Asphalt Construction with Edge and Under-slab Insulation:
 - .1 When using high-density foam insulation board, install the tubing by stapling the tubing to the insulation board with Uponor Foam Staples or approved equivalent.
 - .2 The under-slab insulation shall be rigid 2" polystyrene suitable for underground applications.
 - .3 Install the vertical edge insulation along the perimeter of the slab and down to a depth equal to the bottom of the horizontal under-slab insulation.
 - .4 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 229 mm (9").
 - .5 On a 24" wide band along the platform edge, the piping density shall be increased to the maximum allowed by the manufacturer (6" on centre) regardless of the size of the tubing.
 - .6 Do not install tubing closer than 152 mm (6") from the edge of the heated slab.

- .7 Bedding material for all tubing shall be layer minimum 6" deep of compacted #8 crushed limestone and screenings (3/8" dia.). The fill over the PEX tubing must be void of any sharp material. The pavers are then installed over the compacted soil bed.
- .8 Backfilling of all pipe shall be well compacted by means of jetting or other approved methods to eliminate settling. Any completed areas that show settlement shall be promptly re-backfilled with compacted clean earth
- .9 Metal or plastic bend supports will be used to support the tubing when departing from the slab in a 90° bend.
- .5 Use a 50 mm (2") rigid layer of Styrofoam insulation under the tubing.
- .6 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.
- .7 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.).
- .8 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.
- .9 Provide snow melt radiant heating zones and piping manifold assemblies. System installation is to be in strict accordance with manufacturer's instructions.
- .10 Provide a strainer in piping to manifold supply header and clean strainer screen when system balancing is to commence.
- .11 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.
- .12 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.

3.3 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. 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.

3.4 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.

3.5 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

3.6 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 un-heated 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.

.2 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.

.3 Provide laminated wiring diagrams or modify existing equipment wiring diagrams. Securely attach to the inside of the respective control cabinet.

.4 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.

.5 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.

.6 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.

.7 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.

.8 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°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

3.7 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 $\pm 0.3^{\circ}\text{C}$ 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.
- .2 Valves 50 mm (2") and smaller shall be constructed of bronze. Valves 65 mm (2½") and larger shall have iron bodies and bronze mountings.
- .3 All control valves shall have stainless steel stems.
- .4 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.
- .5 The bodies and bonnets of iron body valves shall conform to ASTM A126, Class B.
- .6 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.
- .7 The control valves shall have tight shut-off. Flat disk valves are not acceptable.
- .8 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.
- .9 The water control valves shall be sized for a pressure drop of 6 ft. water column or as indicated on mechanical drawings.
- .10 Each automatic control valve must provide the design output and flow rates at pressure drops compatible with equipment selected.
- .11 Each automatic control valve must be suitable for the particular system working pressure.
- .12 Each automatic control valve shall be fitted with a position indicator.
- .13 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.

.14 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.

.15 Standard of Acceptance:

.1 Siemens.

.2 Danfoss.

.3 Honeywell.

.4 Or approved equivalent.

3.8 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.
- .7

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes
 - .1 In-slab and poke-through style floor monuments for electrical, communications, and audio/video purposes.
- .2 Related Requirements
 - .1 Section 26 27 26 – Wiring Devices.
 - .2 Section 27 15 13 – Communications Copper Horizontal Cabling.

1.2 REFERENCE STANDARDS

- .1 Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - .1 CSA C22.2 No. 18.1-13 (R2018) - Metallic outlet boxes (Tri-national standard, with UL 514A and ANCE NMJ-J-023/1).

1.3 SUBMITTALS

- .1 Submit manufacturer's catalog cuts and specifications for all floor boxes, and accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 Canadian Electric Raceways.
- .2 Hubbell.
- .3 Wiremold (Legrand).
- .4 Wellmark.
- .5 Steel City.

2.2 FLOOR MONUMENTS, GENERAL

- .1 Power: two duplex 5-20R receptacles.
- .2 Data: up to four voice/data drops.
- .3 Power and Low Voltage Divider.
- .4 Monument lid should be flush with finished floor, and be able to accept a cut-to-fit carpet or vinyl tile.

2.3 FLOOR BOXES

- .1 Floor Boxes: CSA C22.2 No. 18.1, fully adjustable, 38 mm deep.
- .2 Material: Cast metal.
- .3 Shape: Rectangular.

- .4 Service Fittings: As specified in Section 26 27 26.
- .5 Heavy duty lid.

PART 3 - EXECUTION

3.1 COORDINATION

- .1 Coordinate exact pathways of conduits to suit structural conditions.
- .2 Confirm exact conduit sizes with communications trade.
- .3 Install dedicated conduits for power [and data and A/V] for each floor box. Do not daisy chain conduits between floor boxes.

3.2 INSTALLATION

- .1 Contractor to verify the thickness of the floor and select the through floor component that fits floor thickness.
- .2 Install floor box so that cover plates are flush with top of finished floor.
- .3 The electrical documents shall not be used for the purpose of establishing locations of floor outlets. The location of such outlets shall be established by the Architect.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Provide commissioning of fire alarm and interconnected systems to verify that installations are in accordance with project requirements, and to ensure proper system operation.

1.2 RELATED REQUIREMENTS

- .1 Section 01 91 13 – General Commissioning Requirements.
- .1 Section 01 91 26.13 – Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.3 REFERENCES

- .1 CAN/ULC-S1001-11 – Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.4 SUBMITTALS

- .1 Commissioning plan.

1.5 CLOSEOUT SUBMITTALS

- .1 Final commissioning and functional test report.

1.6 QUALIFICATIONS

- .1 Commissioning Organizations:
 - .1 Certified member of Electrical Contractors Association of Ontario (ECAO) or Canadian Fire Alarm Association (CFAA).

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 SITE TESTS AND INSPECTIONS

- .1 Perform Commissioning of integrated systems in accordance with CAN/ULC-S1001.
- .2 Follow manufacturer's recommendations for testing.
- .3 Inspect wiring connections to all devices comprising the system.
- .4 Verify supervision of wiring at every device connection to a supervised circuit.
- .5 Test operation of every device on a system to verify its function.
- .6 Examine equipment for any apparent damage or tampering that may interfere with its intended operation.
- .7 Test equipment with capabilities for field adjustment to establish that it functions as intended under the conditions prevailing at its point of installation.

- .8 Examine devices for evidence of damage or obstructions which may interfere with their operating mechanisms.
- .9 Test automatic devices by simulating an operating condition.
- .10 Wiring:
 - .1 Inspect every device and test to demonstrate that disconnection of the device from the circuit or malfunction of the equipment or wiring activates the required supervisory signals. Inspection shall include verification that:
 - .1 Supervisory signals operate in response to open circuits, short circuits, ground faults and disconnection of plug-in components;
 - .2 Terminations of conductors entering and leaving equipment have been made;
 - .3 Circuit polarities are in accordance with the system design, where applicable.
 - .2 In addition, test to establish that the power supplied to any device is within its recommended operating range and that the required voltage levels are maintained and that the fusing is correct.
- .11 Initiating Devices - Manual:
 - .1 Inspect manual alarm stations in consideration of the following:
 - .1 The device shall be mounted with sufficient clearance to facilitate ease of access and proper operation;
 - .2 Operate each manual alarm station, toggle switch and key switch to verify proper functions.
- .12 Automatic heat detectors:
 - .1 Use a heat source reproducible in its intensity, as recommended by the manufacturer of the device, to initiate an alarm.
 - .2 Test equipment - Heat lamp or Air heater. DO NOT USE AN OPEN FLAME HEAT SOURCE.
 - .3 Apply heat source as to not damage or operate fusible disc parts.
- .13 Automatic heat detectors - non-resettable:
 - .1 Test by simulating its electrical operation by jumpering the wiring points (creating a short) adjacent to its operating mechanism.
- .14 Automatic smoke detectors - area type:
 - .1 Test by introducing smoke into its detecting chamber. This may consist of actual smoke from burning materials or artificially generated smoke aerosol spray as recommended by the manufacturer. The sensitivity should be noted and adjusted if necessary.
- .15 Automatic smoke detectors:
 - .1 Examine the air sampling arrangements of the detectors under actual conditions of balanced air circulation by conducting a check of the field sensitivity and a check of the air velocity in accordance with the manufacturers' recommendations.
 - .2 Test gas to be used similar to Automatic Smoke Detector.
- .16 Alarm signals - audible:
 - .1 Test on main power supply and standby power supply with the maximum expected load on the system.

- .2 The audible signalling appliances shall function as intended and shall be audible throughout the building over the background noise present.
- .3 Decibel recordings in each area covering 100 sq. metres shall be taken.
- .4 The level of sound should usually be 15 dB above ambient noise level.
- .17 Alarm signals - visual:
 - .1 The visual signal appliances shall function as intended and shall be clearly visible.
- .18 Fire suppression supervision:
 - .1 Coordinate with the requirements of Section 21 12 00, and Section 21 13 00.
 - .2 Sprinkler and standpipe trade to activate each sprinkler and standpipe supervisory and alarm device by operating valves and producing flows as required in conjunction with fire alarm technician to observe activation of flow switches, pressure switches, supervised valves, etc.
- .19 Annunciators, printers, and workstations:
 - .1 Inspect and operate to establish that their operation in conjunction with the control equipment and other system components, is as intended. The equipment shall be inspected to ensure:
 - .1 The zone of each alarm initiating device is properly indicated;
 - .2 The legend is clearly visible;
 - .3 Adequate voltage under local conditions is present;
 - .4 Wiring connections have been made in a workmanlike manner.
 - .5 Proper care must be taken to establish that each item is complete and satisfactory.
- .20 Standby power supplies - batteries:
 - .1 Examine batteries for possible damage and consideration of the following:
 - .1 The charging system functions as intended;
 - .2 The installation has not resulted in the bypassing of a fuse or a similar protective device;
 - .3 The installation protects the batteries from accidental or mechanical damage.
 - .4 The batteries must be able to operate the fire alarm system with the charger input disconnected for one rated load cycle.
- .21 Control equipment and transponders:
 - .1 Test to establish that they function as intended. The following examinations and tests shall be performed:
 - .1 A visual and physical inspection of all cables, plug interconnections, plug-in circuit components, lamps, sockets and controls to establish that their mechanical and electrical connections and mounting are as required for intended function and, where applicable, to confirm electrical supervision;
 - .2 Verification that all field wiring is terminated in a workman-like manner;
 - .3 All lamps and indicators shall be tested for operation and intended function;
 - .4 All keypad functions shall be tested for operation and intended function;

- .5 All control unit functions shall be operated to verify appropriate response including all software routines and programme functions are simulated;
- .6 Simulation of open circuits, short circuits and ground faults on all relevant internal circuits in order to confirm the appropriate supervisory response;
- .2 Commissioning Report:
 - .1 Provide in accordance with requirements of Section 01 91 13, supplemented as specified herein.
 - .2 Report to include relevant information of the system including:
 - .3 Each system part described.
 - .4 How the system is operated.
 - .5 What functions the system performs.
 - .6 Requirements for tests and service.
 - .7 Itemization of all devices connected on the system, their general location.
 - .8 The date of the performed tests.
 - .9 All pertinent details of the report sheets requested.
- .3 Verification:
 - .1 The Commissioning Report to be submitted to the Commissioning Manager upon completion of commissioning and will be subject to verification by the Commissioning Manager.

3.2 SIMULATIONS OF INTERCONNECTED SYSTEMS

- .1 Provide simulations of all interconnected systems in accordance with CAN/ULC-S1001.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Single stage addressable fire alarm systems.
- .2 System testing and verification.
- .3 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing, and putting into proper operation a complete Fire Alarm System as shown, as specified, and as otherwise required. Complete system shall be left ready for continuous and efficient satisfactory operation.

1.2 RELATED REQUIREMENTS

- .1 Section 08 71 00 – Door Hardware: additional requirements for access control devices, magnetic door holders, etc.
- [.2 Intentional deleted.](#)
- .3 Section 21 13 00 – Fire-Suppression Sprinkler Systems.
- .4 Section 26 05 00 – Common Work Results for Electrical.

1.3 UNIT PRICES

- [.1 Intentionally deleted](#)
- .2 Submit with Tender unit prices to provide the following. Include installation and verification in the unit price:
 - .1 Section 28 46 31:
 - .1 Fire detector (heat detector or smoke detector) complete with wiring and conduit, based on 10 metre distance.
 - .2 Duct type smoke detector complete with wiring and conduit on a separate zone, based on 30 metre distance.
 - .2 Section 28 46 31.31:
 - .1 Manual pull station, complete with wiring and conduit based on 10 metre distance.
 - .3 Section 28 46 31.41:
 - .1 Zone Addressable Module (ZAM).
 - .4 Section 28 46 41:
 - .1 Fire alarm horn complete with wiring and conduit, based on 10 metre distance.
 - .2 Combination Fire alarm horn/strobe complete with wiring and conduit, based on 10 metre distance.
 - .5 Unit cost of additional conduit and wire for the above items.
 - .6 Wire guard for any fire alarm device.

1.4 REFERENCES

.1 Definitions

- .1 FACP: Fire Alarm Control Panel. This is the central component of a fire alarm/detection/communication system and consists of a control panel(s) and contains the system power supply, system CPU, circuit terminations, and system annunciation functions.
- .2 INITIATION DEVICE: Examples are smoke detectors, heat detectors, water flow switches, valve tamper switches, and manual pull stations. These are devices which initiate a signal and send it to the FACP telling it that an abnormal event has taken place. Data Centre extinguishing systems, kitchen hood extinguishing systems, and other special extinguishing system control panels are additional examples of initiating devices.
- .3 NOTIFICATION DEVICE: Examples are alarm horns, alarm speakers, and strobe lights. These devices are used to indicate through visual and audible means the existence of an abnormal event throughout all areas of the protected premises.
- .4 CONTROL DEVICE: Examples are electronic relays or solenoids. These devices allow the FACP to automatically take certain actions during an abnormal event. For example, the FACP may energize a relay which, in turn, shuts down an air handling unit.
- .5 CENTRAL PROCESSING UNIT (CPU): The central computer of a multiplex fire alarm system.
- .6 CONCEALED: Where used in connection with installation of piping or conduit and accessories shall mean "hidden from sight" as in shafts, furred spaces, soffits or above suspended ceilings.
- .7 EXPOSED: Where used in connection with installation of piping or conduit and accessories shall mean "visible" or "not concealed."
- .8 AHJ: Authority Having Jurisdiction.
- .9 LISTED: Materials or equipment included in a list published by a nationally recognized laboratory that maintains periodic inspection of production of listed equipment and materials, and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner.
- .10 NFPA: National Fire Protection Association.
- .11 CLASS A: Applies to wiring from transponder to central processing unit. The CPU will detect circuit trouble and transponder will retain the ability to transmit alarm upon a single fault condition.
- .12 CLASS B: Applies to wiring from initiating device to transponder. A trouble signal will be transmitted to the panel upon a single fault condition.
- .13 TRANSPONDER: Single or multiple zone/point data collection panel used within a multiplex system.
- .14 UL, and ULC: Underwriters Laboratories, Inc., and Underwriters Laboratories of Canada, Inc.

- .15 ULC Listed: Materials or equipment listed by Underwriters Laboratories of Canada and included in the most recent edition of the UL and ULC Fire Protection Equipment Directory.
- .16 AHU: Air Handling Unit.
- .17 FM: Factory Mutual Research Corporation/Factory Mutual Engineering Association.

.2 Reference Standards

- .1 The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only. The equipment and installation shall comply with the latest edition/amendment referenced code, standard, or publication.
 - .1 CSA Group:
 - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (28th edition/2021).
 - .3 CSA C22.2 No. 208-14 - Fire Alarm and Signal Cable.
 - .2 Ontario Regulations:
 - .1 2012 Ontario Building Code.
 - .2 2007 Ontario Fire Code.
 - .3 Underwriters Laboratories of Canada:
 - .1 CAN/ULC-S524:2019, Standard for Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S525 – Audible Signal Appliances for Fire Alarm Systems.
 - .3 CAN/ULC-S526 – Visual Signal Appliances for Fire Alarm Systems.
 - .4 CAN/ULC-S527 – Control Units for Fire Alarm Systems.
 - .5 CAN/ULC-S528 – Manual Pull Stations for Fire Alarm Systems.
 - .6 CAN/ULC-S529 – Smoke Detectors for Fire Alarm Systems.
 - .7 CAN/ULC-S530 – Heat Detectors for Fire Alarm Systems.
 - .8 CAN/ULC-S533 – Egress Door Securing and Releasing Devices.
 - .9 CAN/ULC-S536 – Inspection and Testing of Fire Alarm Systems.
 - .10 CAN/ULC-S537 – Verification of Fire Alarm Systems.

- .11 CAN/ULC-S548 – Alarm Initiating and Supervisory Devices for Water Type Extinguishing Systems.
- .12 CAN/ULC-S561-13 – Standard for Installation and Services for Fire Signal Receiving Centres and Systems.
- .13 CAN/ULC-S1001-11 (R2018) – Integrated Systems Testing of Fire Protection and Life Safety Systems.
- .4 All requirements of the Authority Having Jurisdiction (AHJ).
- .2 In the case of any discrepancy between these specifications, the project drawings, and any applicable local codes, the installed Fire Alarm / Life Safety System shall comply with the most stringent requirement.

1.5 ACTION SUBMITTALS

- .1 In accordance with Section 01 33 00.
- .2 Product Data: Provide electrical characteristics and connection requirements.
- .3 Submit drawings to municipal Fire Department if required, showing annunciation devices, manual pull stations, complete wiring diagrams and annunciator details and obtain their approval.
- .4 Shop Drawings:
 - .1 Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - .2 Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, and device arrangement, and clearly showing ULC certification of all components.
 - .3 Show annunciator layout and main control panel module layout, configurations and terminations.
 - .4 Floor plan layouts showing all devices.
 - .5 Complete riser diagram, and auxiliary functions.
 - .6 The supplier of the system shall prepare a complete zoning schedule and artwork layout for passive graphic to be included with submittal package.
 - .7 Sequence of Operation narrative and zone chart.

1.6 INFORMATIONAL SUBMITTALS

- .1 Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of products.

1.7 CLOSEOUT SUBMITTALS

- .1 Maintenance Contracts
 - .1 Provide service and maintenance of fire alarm system for one year from Date of Substantial Completion.
- .2 Operation and Maintenance Data

- .1 Operation Data: Operating instructions.
 - .2 Maintenance Data: Maintenance and repair procedures.
- .3 Record Documentation
 - .1 Record actual locations of initiating devices, signaling appliances, and end-of-line devices.
 - .2 Electrical Safety Authority (ESA) inspection certificate.
 - .3 Fire alarm verification report.
 - .4 Audibility test.
 - .5 CAN/ULC-S1001 functional test report.
- .4 Manuals
 - .1 Submit complete operating and maintenance manuals listing the manufacturer's name(s) including technical data sheets (with model numbers to be used indicated).
 - .2 Wiring diagrams shall indicate terminals and the interconnections 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.

1.8 SPARE PARTS

- .1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.
 - .1 Supply six keys of each type.
 - .2 Supply two of each type of addressable detector base, smoke detector, heat detector, and fire alarm pull station.
 - .3 Supply two of each type of other installed initiating, notification, or controlling devices.
 - .4 Supply three of each type of any special tools required for system use and maintenance.
 - .5 Supply two of each type of signalling device used on the project.

1.9 QUALITY ASSURANCE

- .1 Manufacturer shall examine drawings and specifications prior to award of contract to ensure that detectors, control panels and miscellaneous devices being supplied will provide a satisfactory working installation.
- .2 Each and all items of the fire alarm system shall be listed as the products of a single manufacturer under the appropriate category by Underwriters Laboratories of Canada and shall bear the "ULC" label.
- .3 The fire alarm control, panel shall meet the modular listing requirements of ULC. Each subassembly of the FACP, including all printed circuit boards, shall include the appropriate ULC modular label.

- .4 Each and all items of the fire alarm system shall be covered by a one-year parts and labour warranty covering defects resulting from faulty workmanship and materials. The warranty shall be deemed to begin on the date the system is accepted by the Project Manager on issuance of the substantial performance certificate for the project.
- .5 Regulatory Requirements
 - .1 Provide products listed and classified by ULC as suitable for purpose specified and indicated.
- .6 Qualifications of Manufacturer
 - .1 Equipment and materials shall be provided by an experienced reputable manufacturer to ensure proper specification adherence, final connection, test, turnover, warranty compliance, and service.
 - .2 The manufacturer is required to have been in the fire alarm industry (service and installation) for a minimum of ten years.
 - .3 The manufacturer shall have in-house engineering and project management capability consistent with the requirements of this project. Qualified and approved representatives of the system manufacturer shall perform the detailed engineering design of central and remote control equipment.
 - .4 International Standards Organization. The system and all components will be manufactured to ISO 9001 international Quality Management and Quality Assurance Standards.
 - .5 Manufacturer must have service facilities within a 50 km radius of the installation location.
- .7 Qualifications of Installers
 - .1 All work performed to comply with this specification shall be carried out by and/or managed by a competent firm regularly engaged in the installation and testing of fire alarm systems for commercial buildings. Equipment manufacturer shall also be competent firms which are regularly engaged in the design, installation, testing, and servicing of fire alarm systems for this type of building.
 - .2 Review of cut-sheets, shop drawings, calculations and other materials submitted by the contractor shall not relieve the contractor's responsibility for full compliance with the design drawings and specification unless written approval is requested by the contractor and obtained from the Consultant for each non-complying feature. Finalized agreements for all equipment deviations from the drawings and specification shall be completed prior to award of the installation contract.
 - .3 For those instances where the contractor cannot conform to the drawings and specification, a proposed variance shall be submitted in writing to the Consultant at least five working days prior to the bidding date. The Consultant will respond to all proposed variances within two working days of receipt.
 - .4 All questions concerning interpretation of the design drawings and specification shall be submitted to the Consultant in writing no later than three working days prior to the bidding date. Requests for interpretations received after this date will not be answered. The Consultant will respond

to all requests for interpretations in writing and will provide a summary of each request and the response to all bidding contractors. The Consultant will respond to all requests for interpretations within two working days of receipt.

- .5 The contractor shall utilize the services of a fire alarm equipment distributor who is a factory authorized representative and a full line stocking distributor of the equipment manufacturer and shall maintain a constant inventory of the parts typical of those used in the system installation covered under this specification.
- .6 The contractor and the fire alarm equipment manufacturer or distributor shall each have a minimum of 7 years of continuous experience in the design and/or installation of fire alarm systems and shall have completed a minimum of five projects of similar scope and complexity which were completed using addressable/analog systems. It is intended that these projects incorporated the same equipment, manufacturer, and model number, as is being proposed for this project. To verify the qualifications, the contractor and the fire alarm equipment distributor shall submit a brief design narrative which covers at least five fire alarm systems selected for references. This narrative shall indicate the project location, approximate contract value, system size by device counts, and a functional overview. These narratives shall provide an end-user contact name and telephone number for each referenced system. Where a fire alarm equipment distributor is a branch office of a fire alarm manufacturer, the references shall be chosen from projects in which the branch office completed both the design implementation and the installation.
- .7 The Owner reserves the right to request documentation from the contractor with respect to any pending litigation against the contractor or any subcontractor. Further, the Owner reserves the right to review an audited financial statement of the contractor or any subcontractor for the most recently completed fiscal year.
- .8 The Owner reserves the right to disqualify any contractor who does not comply with all requirements of the Contractor Performance Standard of this specification.
- .9 Installer must be certified by the Province of Ontario as a fire alarm installer.

1.10 DELIVERY, STORAGE, AND HANDLING

- .1 In accordance with Section 01 61 00.

1.11 WARRANTY

- .1 All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one year from the date of Substantial Performance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality.
 - .1 Autocall 4100ES series.
 - .2 Edwards; EST4 series.
 - .3 Notifier by Honeywell; Onyx NFS2-640C series.
 - .4 Mircom; FX-4000 series.
 - .5 Siemens; Desigo series.
 - .6 SimplexGrinnell by Tyco Integrated Fire & Security; 4100ES series.
- .2 All equipment and components shall be the manufacturer's current model.
- .3 The materials, appliances, equipment, and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system.
- .4 The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.
- .5 The contractor shall provide, from the acceptable manufacturer's current product lines, equipment, and components, which comply, with the requirements of these specifications.
- .6 Manufacturer is to support a 20 year product.

2.2 CONDUIT AND WIRE FOR FIRE ALARM SYSTEM

- .1 Conduit:
 - .1 In accordance with Section 26 05 33.13.
 - .2 Conduit shall be in accordance with the Electrical Safety Authority (ESA), local and provincial requirements.
 - .3 All wiring shall be installed in conduit or raceway.
- .2 Terminal Boxes, Junction Boxes and Cabinets:
 - .1 All boxes and cabinets shall be listed for their purpose and use.
- .3 Fire Alarm Cable
 - .1 Wiring shall be in accordance with local, provincial and national codes and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as outlined in the Ontario Electrical Safety Code and as recommended by the fire alarm system manufacturer.
 - .2 All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signalling system, as outlined in the Ontario Electrical Safety Code.
 - .3 Conductors: 300 V rated multiconductor, insulated, colour coded, copper conductor, minimum size to be 16 AWG for device loops and 14 AWG for signal circuits.

- .4 Certified by CSA as fire alarm and signal cable type FAS 105 to CSA C22.2 No. 208.
- .5 Non-Fire rated cable:
 - .1 Insulation: 105°C flame retardant PVC
 - .2 Outer Jacket: 105°C flame retardant PVC Red.
 - .3 Armour: Interlocking aluminum without overall jacket. For drops to devices in suspended ceilings from conduit system.
- .6 Fire rated fire alarm cable:
 - .1 Pentair Pyrotenax 1850 series mineral insulated (MI) cable with 2 hour fire rating to ULC S139 and to meet 2012 Ontario Building Code rule 3.2.7.10.
 - .2 Substitution: VITALink MC Brand Type MC, manufactured by Marmon Wire & Cable Inc. (listed by ULC under ULC category code 'FHJRC', dated 19 May 2015).

2.3 ADDRESSABLE FIRE ALARM SYSTEM

- .1 The system to be electrically supervised, non-coded, annunciated, single-stage, addressable fire alarm system using addressable devices.
- .2 The Central Processing Unit (CPU) uses multiplex communication techniques to receive data from and transmit data to transponders remotely located throughout facility to minimize wiring costs, simplify design, to allow economical expansion and easy retrofit.
- .3 Make provisions during detailed design for future expansion of the system.
- .4 System to be complete with a minimum of three data loops per node.
- .5 The CPU is microprocessor-based to increase system reliability, speed response to alarm conditions, and reduce cost. CPU response time to alarm conditions to be no more than four seconds, regardless of system size.
- .6 Fire alarm system will be zoned as required plus 20 per cent spares.
- .7 Basic Performance:
 - .1 Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.
 - .2 Provided with an emergency power supply, i.e. batteries capable of providing supervisory power for not less than 24 hours, and immediately following, emergency power under full load for not less than two hours.

2.4 FIRE ALARM ANNUNCIATOR PANEL (FAAP) AND GRAPHIC

- .1 To Section 28 46 21.22.

2.5 ULC MONITORING TRANSMITTER

- .1 To Section 28 46 21.24.

2.6 FIRE ALARM SYSTEM ACCESSORIES

- .1 To Section 28 46 25.

2.7 FIRE ALARM INITIATION DEVICES

- .1 Automatic Initiating Devices to Section 28 46 31.
- .2 Manual Pull Stations to Section 28 46 31 31.
- .3 Supervisory Signal devices and Sprinkler Flow Switch alarms to Section 28 46 31.41.

2.8 FIRE-ALARM SUPERVISED INTERFACE HARDWARE

- .1 Door Hardware Fire Alarm Integration to Section 28 46 51.08.
- .2 HVAC Integration to Section 28 46 51.23.

2.9 SIGNALLING DEVICES

- .1 Horns and visual signal devices (strobes) to Section 28 46 41.
 - .1 Strobe Frequency: maximum 5 Hz.
- .2 Programmable Electronic Sounders:
 - .1 Shall be flush mounted as required.
- .3 Audible/Visual Combination Devices:
 - .1 Shall meet the applicable requirements listed above for audibility.
 - .2 Shall have a built in strobe, 75 candela.
- .4 Strobe Synchronizing Modules:
 - .1 Synchronize strobes at 1 Hz and horns at temporal over single wire pan.

2.10 OPERATION SEQUENCE

- .1 To Section 28 46 15.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 The entire system shall be installed in accordance with the edition of CAN/ULC-S524 as adopted by the applicable legislation, and the manufacturer's manuals and wiring diagrams.
- .2 The contractor shall furnish all labour, conduit, wiring, outlet boxes, junction boxes, cabinets, and similar devices necessary for a complete, functional life safety fire alarm system.
- .3 Provide all necessary power supply, interconnecting and remote signal wire in dedicated conduit throughout and installed in accordance with the manufacturer's wiring diagrams and the requirements of the Canadian Electrical Code and the Inspection Authority.
- .4 All penetration of floor slabs and fire walls shall be fire stopped in accordance with all local fire codes.
- .5 Power supply:
 - .1 Connect fire alarm system power supply to a dedicated circuit.

- .2 Circuit breaker(s) feeding fire alarm system to be coloured red, clearly labelled, and be locked in the ON position.
- .6 Wiring:
 - .1 Install all wiring in metal raceways.
 - .2 Provide wiring suitable for fire alarm circuits.
 - .1 Class "A" wiring for initiating circuits.
 - .2 Class "A" wiring for signalling circuits unless noted otherwise.
 - .3 Provide fire rated cables for fire alarm circuits as required by applicable codes and standards.
 - .4 Provide separate signalling circuits for audible and visual devices.
- .7 Install manual pull stations at 1200 mm above finished floor.
- .8 Identification
 - .1 Provide lamacoid label (white text on red background) for all supporting field devices indicating function of the device.

3.2 FIELD QUALITY CONTROL

- .1 The installing contractor shall provide a qualified project superintendent for the overall management and supervision of the work.
- .2 The project superintendent shall assure that adequate supervision is provided during all periods of installation of the fire alarm system. The project superintendent and all job site supervisors shall have a minimum of five years of continuous experience in the installation of fire alarm systems of similar scope and complexity.
- .3 Upon completion of the installation, the installing contractor shall test all alarm initiating devices, supervisory devices, control devices and notification devices for proper response and effectiveness. Operation of all annunciating devices including the FACP, printer and remote LCD panel shall be verified. Testing shall include thorough sound level measurements of audible notification devices. These tests shall be fully documented. All testing up to the point of conducting the final acceptance tests shall be recorded using a temporary printer. The permanent printer of the system, where such has been provided, shall not be installed prior to the final acceptance tests.
- .4 All smoke detectors shall be suitably protected against contamination up to the time of the final acceptance tests.
- .5 An itemized test report in accordance with CAN/ULC-S524, CAN/ULC-S536, and CAN/ULC-S537 shall be submitted to the Consultant. This report shall provide complete details of the testing completed for all devices as well as circuit testing parameters. Data shall be submitted indicating the sensitivity level of all system smoke detectors.
- .6 Following completion of a 100 per cent system functional test, the contractor shall perform a thorough acceptance test of the system at the direction of and to the satisfaction of the Owner and Consultant. This test shall not be carried out until at least 15 days after completion of all contractor's testing, modification and repairs following the original contractor's functional test and submittal of the functional testing documentation to the Consultant. The 15 day interval is also intended to be a system "burn-in" period. Any false activations of the system which occur within the burn-in period which are determined to be the result of a system fault shall result in the restart of the 15 day period.

- .7 In the event that the acceptance test of the system results in the need for system repair or modification, the contractor shall demonstrate the operability of the system to the full satisfaction of the Owner and Consultant following the completion of repairs or modification.
- .8 In the event that the AHJ requires a separate demonstration of the operability of the system for acceptance purposes, these additional tests shall be carried out by the Contractor without expense to the Owner.
- .9 The contractor shall conduct an independent quality assurance review of all developed "record" drawings to assure accuracy and completeness of these drawings. Any discrepancies shall be brought to the attention of the Consultant prior to construction start.
- .10 Only directly prior to verification, remove smoke detector protectors, and clean smoke detectors thoroughly.
- .11 Inspect and check each individual device in entire system for proper connection, supervision, and function in accordance with CAN/ULC-S537. Identify detectors, manual pull stations and signal appliances not installed within requirements of CAN/ULC-S524 in remarks column of verification report.
- .12 Obtain verification certificate and verification report from manufacturer showing each device checked, and that work has been carried out. Utilize standard verification forms similar to Canadian Fire Alarm Association (CFAA) forms.

3.3 ADJUSTING

- .1 Contractor to verify programming of room names prior to fire alarm system programming, and allow for a revision to the fire alarm system programming should the Owner or AHJ wish to revise the room names.

3.4 MONITORING

- .1 Fire alarm control panel to be located as indicated. Coordinate third party CUL Listed monitoring with Owner.

3.5 MANUFACTURER SERVICES

- .1 At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.
- .2 The manufacturer's representative shall perform an inspection of the fire alarm equipment, including those components necessary to the direct operation of the system such as manual stations, thermal and smoke actuated detectors and controls, whether or not manufactured by the manufacturer. The inspection shall comprise an examination and test of such equipment for the following:
 - .1 That the type of equipment installed is that designated by the specifications.
 - .2 That the wiring connections to all equipment components show that the installer undertook to have observed ULC requirements. That all products of combustion (smoke) detectors have been properly calibrated, and adjustments set correctly.
 - .3 That the representative's equipment has been installed in accordance with the manufacturer's recommendations.

- .4 That the supervisory wiring of all devices connected to a supervised circuit is operating and that the wiring, having been met to the satisfaction of the inspecting officials.
- .3 Testing to be done in the presence of the local building inspector, and the local fire inspector.
- .4 The manufacturer(s) of the fire alarm shall make a complete inspection of all components installed for system(s), such as manual stations, horns, and annunciators and sprinkler and standpipe valves and smoke detectors to ensure the following:
 - .1 That the system is complete in accordance with Specifications.
 - .2 That the system is connected according to ULC requirements.
 - .3 That the system is connected in accordance with the manufacturer's recommendations.
 - .4 That the regulations concerning the supervision of components have been adhered to (e.g. stations, detectors, supervised valves, bells), and are properly wired and supervised.
 - .5 That all valves are properly connected and displayed correctly on each annunciator.
 - .6 That any subsequent changes necessary to conform to the above will be carried out with technical advice supplied by the Manufacturer.
 - .7 That all thermal detectors, smoke detectors and manual pull stations have been operated and are in good working order.
 - .8 That all sprinkler system and standpipe system valves have been operated and are in good working order.
 - .9 That all annunciators correctly pin-point the origin of any fire alarm.
 - .10 That actual smoke concentration of sufficient density, have been applied to each smoke detector to cause the detector to be set off and that the sensitivity of each smoke detector has been set.
 - .11 That all devices are in good working order. Include for replacing any defective/damaged devices at no extra cost to Owner.
 - .12 That signal audibility is acceptable in all areas. Submit audibility readings for every Room.

3.6 SITE TESTS AND INSPECTIONS

- .1 Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.
- .2 All initial testing shall be in accordance with the latest issue of ULC-S537 Verification of Fire Alarm Systems standard.
- .3 Provided integrated testing of life safety systems in accordance with Section 28 08 46.
- .4 A representative of the electrical contractor shall be present to participate and assist the manufacturer representative during the course of the verification. The electrical contractor shall make good any deficiencies discovered during the verification. Verify all devices. The electrical contractor shall provide one person for assistance with the verification.
- .5 The verification report shall be submitted for approval to the Consultant.

- .1 Ensure verification report uses room numbers and space descriptions that are consistent with the drawings.
- .6 On completion of the inspection the manufacturer shall supply a certificate, together with detailed inspection record sheets showing location of each device and certifying the test results per unit, confirming that the system is installed, supervised, and operate in accordance with Article "System Verification".
- .7 Audibility Test:
 - .1 Provide audibility test of signalling devices after other systems have been commissioned to verify operation at ambient sound levels.
 - .2 Provide audibility test report to the Consultant.
 - .3 Implement varied tone to suit audibility requirements.

3.7 CLOSEOUT ACTIVITIES

- .1 The System Supplier shall schedule and present documented formalized instruction for the building owner, detailing the proper operation and maintenance of the installed System.
- .2 The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.
- .3 The instruction shall cover the schedule of maintenance required by ULC and any additional maintenance recommended by the system manufacturer.
- .4 Instruction shall be made available to the Local Municipal Fire Department if requested by the Local Authority Having Jurisdiction.
- .5 The contractor shall provide for a minimum of three training sessions of two hours in length. At least one of these training sessions shall be carried out for key personnel prior to the system being initially placed on-line for the beginning of the burn-in period.
- .6 Three bound copies which summarize the training instruction shall be submitted to the Owner for future reference.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Single stage addressable fire alarm system Sequence of Operation.

1.2 RELATED REQUIREMENTS

- .1 Section 28 46 13 – Fire-Alarm Systems.

1.3 CLOSEOUT SUBMITTALS

- .1 Manuals
 - .1 Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 The sequence listed below is representative sequence of operation, based on typical buildings.
- .2 The Contractor shall submit a project specific sequence of operation, as part of the submittal process.

2.2 OPERATION SEQUENCES

- .1 An alarm is caused by actuation of any one of the following devices:
 - .1 Pulling a manual station.
 - .2 Operation of an automatic fire alarm detector.
 - .3 Operation of a sprinkler flow switch.
 - .4 Operation of a smoke detector.
- .2 If, in any area of the building, an alarm is caused by actuation of the aforementioned devices, the following shall occur:
 - .1 Signals in the building shall sound.
 - .2 Annunciators shall indicate exact zone where alarm originated.
- .3 The activation of a manual pull station, automatic fire detector, automatic smoke detector, or sprinkler flow switch shall initiate the following sequence of operation:
 - .1 Sound an alarm signal throughout building.
 - .2 Control panel and remote annunciators shall indicate exact location of alarm via a zoned RED LED.
 - .3 Fans shall be automatically turned off.
 - .4 Initiate alarm origin on CPU and at graphic annunciator.
 - .5 Display the alarm event on all annunciator panels.
 - .6 Actuate CPU causes evacuation signal to sound and strobes to operate.

- .7 The internal audible device shall sound at the control panel.
- .8 Signal transmission to external systems:
 - .1 Transmit signal to monitoring station.
 - .2 Central station shall be automatically alerted via telephone lines connected for fire alarm system.
 - .3 Transmit signal to Building Automation System.
 - .4 Transmit signal to Access Control System.
- .9 Door Releases:
 - .1 All stairwell/exit doors shall unlock throughout the building.
 - .2 All self-closing fire/smoke doors held open shall be released.
- .10 HVAC Shutdowns:
 - .1 Activate smoke dampers.
- .11 CPU indicates trouble when any fault occurs within the system.
- .4 Alarm:
 - .1 Actuate CPU causes evacuation signal to sound and strobes to operate.
 - .2 The internal audible device shall sound at the control panel.
 - .3 Signal transmission to external systems:
 - .1 Transmit signal to monitoring station.
 - .2 Transmit signal to Building Automation System.
 - .3 Transmit signal to Access Control System.
 - .4 Door Releases:
 - .1 All stairwell/exit doors shall unlock throughout the building.
 - .2 All self-closing fire/smoke doors held open shall be released.
 - .3 Site entrance and exit gates open.
 - .5 HVAC Shutdowns:
 - .1 Shut down air supply and return air fans.
 - .2 Activate smoke dampers.
- .5 Supervisory
 - .1 If, in any area of the building, supervised valves of the sprinkler, systems are operated or exhibit short or open circuits, the following shall occur:
 - .1 The annunciator shall identify, as a separate zone, the item causing the trouble signal.
 - .2 The trouble buzzer on the annunciator(s) shall sound.
 - .3 The signals in the building shall not be sounded.
 - .2 The activation of a sprinkler supervised valve or pressure switch shall initiate the following sequence of operation:

- .1 The control panel and remote annunciator shall indicate exact location of activity via a zoned AMBER LED
 - .2 Activate an audible tone on the control panel and remote annunciator.
 - .3 The signals in the building shall not be sounded.
- .6 Trouble
- .1 A short, ground fault or open circuit to any fire alarm conductor, the tamper or removal of any field device or the loss of primary or standby power to any control equipment will result in the following trouble sequence of operation:
 - .1 The control panel and remote annunciator shall indicate exact location of activity via a zoned YELLOW LED.
 - .2 Activate an audible tone on the control panel and remote annunciator.
 - .3 The signals in the building shall not be sounded.

PART 3 - EXECUTION – NOT USED

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes
 - .1 Fire Alarm Control Panel.
 - .2 Fire alarm power supplies and batteries.

1.2 RELATED REQUIREMENTS

- .1 Section 28 46 21.22 – Fire-Alarm Remote Annunciators.
- .2 Section 28 46 21.24 – Supervising Station Alarm Systems Communications Equipment.

1.3 REFERENCES

- .1 Design, manufacture, install and test fire alarm system in accordance with good industry practice and in accordance with the following Codes and Standards:
 - .1 CAN/ULC-S524-14 – Standard for the Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S536-13 – Standard for the Inspection and Testing of Fire Alarm Systems.
 - .3 CAN/ULC-S537-13 – Standard for the Verification of Fire Alarm Systems.
 - .4 CAN/ULC-S527-11 – Control Units for Fire Alarm Systems.
- .2 If any of the requirements of the above Codes and Standards is in conflict with the Drawings or Specifications, the Code or Standard requirements shall govern, but in no instance shall the standards established by these Drawings and Specifications be reduced by any of the Codes and Standards listed above.

1.4 ACTION SUBMITTALS

- .1 Submit shop drawings in accordance with Section 01 33 00 and items noted below. Documentation to be project specific.
 - .1 Generic documentation and/or alternate or as-equal products are unacceptable.
 - .2 Product data for each type of system component including list of materials and Underwriters' Laboratories of Canada (ULC) listing. Product data to include technical documentation features, and/or functions, and parts list.
 - .3 Dimensioned drawings illustrating minimum clearances and any required access space.
 - .4 Point to point wiring diagrams of the entire installed system differentiating clearly between factory and field installed wiring. Identify all terminals and interconnections including conductor numbering.

1.5 INFORMATIONAL SUBMITTALS

- .1 Dimensional elevation of fire alarm control panel and mounting instructions.

1.6 CLOSEOUT SUBMITTALS

- .1 In accordance with Section 01 78 00.

- .1 Operation and Maintenance Manuals: Data on each product type including all features and operating sequences for both automatic and manual operations including trouble shooting and maintenance instructions, schematic and wiring diagrams, final reviewed shop drawings, manufacturer's warranty and verification test report.
- .2 Final device address list and application program listing for the system as installed at the time of acceptance.
- .3 A list of all input and output points in the system with a label indicating location or use of initiating device circuit, notification appliance circuit, relay, sensor, and auxiliary control circuits.
- .4 System power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per ULC standards.
- .5 Operating instructions for control panel.
- .6 Installation and programming manuals covering the installed system.
- .7 All final and certified documentation.
- .8 Drawings in PDF format.
- .2 Operations and Maintenance Manuals: Submit such manuals in accordance with Division 01, and prior to completion of project, in triplicate, containing following:
 - .1 Actual system functional description, and sequence of operation of completed installation.
 - .2 Detailed maintenance instructions for control equipment and each device type, maintenance schedule in accordance with CAN/ULC-S536. Trouble shooting guide for control panels and devices.
 - .3 Pictorial drawing of control equipment layout, showing location of components, modules and parts, indicating catalogue numbers.
 - .4 Schematic diagrams of control equipment, except modules which can be exchanged as unit and internal interconnecting cables and wires.
 - .5 Copy of verification certificate, verification report and warranty certificates such as for fire alarm system, batteries, ancillary devices, including battery suppliers date coding for batteries.
 - .6 Name, address and telephone number of service representative of manufacturer to be contacted during warranty period.
 - .7 Name, address and telephone number of representative responsible for future software programming changes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- .1 Keys.

1.8 QUALITY ASSURANCE

- .1 Testing Personnel Qualifications: In addition to the requirements specified in [Division 01 Section "Quality Control"], provide persons currently certified by the Canadian Fire Alarm Association (CFAA) for fire alarm system testing and verification, to supervise on-site testing and verification as specified in Part 3.
- .2 Installer Qualifications: Engage an experienced factory-authorized installer to supervise work of this Section.

- .3 Single-Source Responsibility: Obtain fire alarm components from a single source who assumes responsibility for compatibility of system components.
- .4 Compliance with Local Requirements: Comply with the applicable building code, local ordinances, and regulations, and the requirements of the authorities having jurisdiction.
- .5 Listing and Labelling: Provide fire alarm systems and components specified in this Section that are listed and labelled by ULC.

1.9 TESTING AND COMMISSIONING

- .1 Perform testing and commissioning services described herein, after fire alarm, visual and audible signalling system has been installed and pretested.

1.10 WARRANTY

- .1 Provide a warranty for materials and workmanship, including microprocessor components and software, to be free of defects for period from date of acceptance of system by Owner in accordance with the General Conditions.
- .2 Repair response times for problems defined as routine to be addressed and corrected within twenty-four (24) hours, excepting statutory holidays and weekends.
- .3 Repair response times for problems defined as major to be addressed and corrected within four (4) hours, excepting statutory holidays and weekends.
- .4 Contractor to provide a recommended list of spare components and devices.
- .5 Manufacturers of the major components to provide written confirmation of full warranty, extended warranty and service back-up in case of the failure to perform or insolvency of the successful supplier.
- .6 Maintain maintenance records for each system supplied, and must submit a monthly report containing a time and date record of all reported or detected problems, detail of corrective action taken and the cause of the problem.
- .7 At end of warranty period, perform tests described above, and in accordance to CAN/ULC-S536 annual inspection and produce a final inspection report.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 The Central Processing Unit (CPU) to use multiplex communication techniques to receive data from and transmit data to transponders remotely located throughout the facility to minimize wiring costs, simplify design, to allow economical expansion and easy retrofit.
- .2 Make provisions during detailed design for future expansion of the system.
- .3 The CPU is microprocessor-based to increase system reliability, speed response to alarm conditions, and reduce cost. CPU response time to alarm conditions to be no more than four seconds, regardless of system size.
- .4 Fire alarm system will be zoned as required plus 20 per cent spares.

2.2 FIRE ALARM CONTROL PANEL

- .1 Fire Alarm Control Panel (FACP) complete with Central Processing Unit (CPU) shall be housed in a surface wall mounted cabinet with baked enamel finish, full viewing window, and hinged front door cover complete with lock and [two] keys.
 - .1 Opening cabinet door shall provide access to all operating controls, but will not expose live electrical connections.
 - .2 Cabinet provided with sufficient capacity to allow maximum system expansion and to house alphanumeric display.
- .2 Modules: concentrated in single central location in modular central control panel.
- .3 Control panel, with number of zones as identified on fire alarm schedule plus 20% spare capacity, shall contain the following:
 - .1 Reset button, LED test button, alarm signal silencing push button, ground fault indicator light, system trouble indicating light, trouble signal silencing button and annunciator trouble indicating light.
 - .2 Relays and control modules as required for door releases, fan shut-down, extinguishing system release, and audible alarms.
 - .3 Alarm receiving modules for number of zones as indicated on drawings plus provision for 20% spares. Zone modules shall be capable of handling any type of device including pull stations, smoke detectors, and heat detectors to allow for future changing of devices without changing modules. Each module to contain a trouble alarm indicator.
 - .4 Power supply modules as required.
 - .5 Signal control modules as required.
 - .6 All modules shall have visual supervision against removal.
- .4 Ancillary functions:
 - .1 Each ancillary function of the fire alarm system shall have its own independent bypass switch, (i.e. fans, door holders, security locks, bells, elevator homing, BMS, monitoring, etc.). Each switch is to be clearly labeled with LED annunciation of its normal and active positions.
 - .2 The panel shall contain enough bypass switches with a least 3 spares to provide each special system and/or ancillary system with bypass capability.
- .5 Power supply: self-contained unit, with integral power supply, battery charger, and standby batteries. Short circuit, over voltage, and brown-out monitoring to protect powered components by automatically switching to standby batteries whenever trouble condition exists in power supply.
- .6 As a result of alarm conditions received at the FACP, the system shall have ability to automatically operate specified control points such as CAN/ULC-S561 monitoring, or stopping exhaust fans, air conditioning units, and releasing magnetically held doors or other Fire Alarm related devices.

2.3 POWER SUPPLIES

- .1 The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 24 hours with 2 hours of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.

- .2 All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit or transponder.
- .3 The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously while incoming power is present.
- .4 The system batteries shall be supervised so that a low battery or depleted battery condition or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
- .5 The system shall support 100% of addressable devices in alarm, or operated at the same time, under both primary (AC) and secondary (battery) power conditions.
- .6 Loss of primary power shall annunciate a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.
- .7 120 V, 60 Hz as primary source of power for system.
 - .1 Provide one 120 V circuits to each FACP, or as directed by fire alarm system manufacturer.
- .8 Standby batteries: sealed, maintenance free, lead calcium sealed batteries.
 - .1 The batteries shall be sealed maintenance free type with expected life of ten years.
 - .2 Batteries shall be enclosed in a steel housing, or within the fire alarm control unit.
 - .3 A fully automatic battery charger shall be provided which shall be capable of restoring a dead battery's capacity per ULC standards.
- .9 Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install to CAN/ULC-S524.
- .2 Control Panel mounting height: arranged such that visual displays and operating controls are not less than 600 mm and not more than 1800 mm above the finished floor level.
- .3 Power to be provided by 120 VAC circuit.
- .4 Label batteries with the in-service date.
- .5 Install Fire Alarm System components as follows:
 - .1 Install fire alarm control panel where shown on drawings.

3.2 FIELD QUALITY CONTROL

- .1 Verification in accordance with Section 28 46 13.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Fire alarm annunciator panels.
 - .1 Main annunciator panel and remote LCD annunciator panels.
- .2 Firefighter entrances.
- .3 Passive graphics.

1.2 RELATED REQUIREMENTS

- .1 Section 21 13 00 – Fire-Suppression Sprinkler Systems.
- .2 Section 26 05 00 – Common Work Results for Electrical.
- .3 Section 28 46 13 – Fire-Alarm Systems.

1.3 REFERENCE STANDARDS

- .1 The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only. Comply with the latest edition/amendment referenced code, standard, or publication.
 - .1 Ontario Regulations
 - .1 Ontario Building Code.
 - .2 Ontario Fire Code.
 - .2 Underwriters Laboratories of Canada
 - .1 CAN/ULC-S524 – Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S525 – Audible Signal Appliances for Fire Alarm Systems.
 - .3 CAN/ULC-S526 – Visual Signal Appliances for Fire Alarm Systems.
 - .4 CAN/ULC-S527 – Control Units for Fire Alarm Systems.
 - .5 CAN/ULC-S528 – Manual Pull Stations for Fire Alarm Systems.
 - .6 CAN/ULC-S529 – Smoke Detectors for Fire Alarm Systems.
 - .7 CAN/ULC-S530 – Heat Detectors for Fire Alarm Systems.
 - .8 CAN/ULC-S533 – Egress Door Securing and Releasing Devices.
 - .9 CAN/ULC-S536 – Inspection and Testing of Fire Alarm Systems.
 - .10 CAN/ULC-S537 – Verification of Fire Alarm Systems.
 - .11 CAN/ULC-S548 – Alarm Initiating and Supervisory Devices for Water Type Extinguishing Systems.
 - .12 ULC/ORD 693 – Central Station Fire Protective Signaling.
 - .3 All requirements of the Authority Having Jurisdiction (AHJ).
- .2 In the case of any discrepancy between these specifications, the project drawings, and any applicable local codes, comply with the most stringent requirement.

1.4 COORDINATION

- .1 Coordinate between all trades for inclusion of information to be included on passive graphic.

1.5 ACTION SUBMITTALS

- .1 In accordance with Section 01 33 00, and Section 28 46 13.
- .2 Shop Drawings:
 - .1 Annunciator:
 - .1 Provide annunciator layout and system wiring diagram showing each device and wiring connection required.
 - .2 Show annunciator layout and main control panel module layout, configurations, and terminations.
 - .2 Passive Graphic:
 - .1 Prepare a complete zoning schedule and artwork layout for each passive graphic to be included with submittal package.
 - .2 Submit colour PDF (electronic submittal) using the identical colours as will be used in a temporary graphic for use during occupancy review by municipal fire inspector.
 - .3 After occupancy review, incorporate comments from municipal fire inspector, and submit colour PDF (electronic submittal) using the identical colours as will be used in the final production graphic.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 In accordance with Section 01 61 00.

1.7 WARRANTY

- .1 All work performed and all material and equipment furnished to be warranted as free from defects and for a period of at least one year from the date of acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 In accordance with Section 28 46 13.

2.2 FIRE ALARM ANNUNCIATOR PANEL (FAAP)

- .1 Annunciator panels will have an alphanumeric display for each detection device, and will identify the detection device initiating an alarm.
- .2 Annunciator panel located at the firefighter's entrance will have separate zone indication for each zone.
- .3 Install panel in a recessed enclosure with brushed aluminum finish [to suit the construction of the vestibule]. Coordinate exact location and dimensions with Architectural drawings.

- .4 Identify emergency exit door numbers/identifiers, and on the control panel/annunciator panel LED labels in order to identify the manual pull stations adjacent to said doors when being activated when cross referenced with the passive graphic.

- .1 Coordinate with architectural plans indicating door IDs.

2.3 PASSIVE GRAPHIC DISPLAYS

- .1 Provide passive colour graphic display to be mounted adjacent to the fire alarm control panel and each annunciator panel as indicated on the drawings.

- .1 Provides building and zone layout while defining zone boundaries.

- .2 Visual reference of user's location within the building.

- .2 Multicoloured Passive Graphics:

- .1 Plastic laminate type, on white background, framed and under plexiglass, 600 mm by 600 mm (24 inch by 24 inch) minimum size.

- .2 Different brilliant colours used to distinguish the various fire alarm zones and building outline from one another, silk-screened with durable acrylic-based inks on a white matte 3 mm (1/8 inch) thick acrylic sheet. Use UV protected inks to protect against fading or colour changes for life.

- .3 Provide a minimum of six different colours.

- .4 Uppercase text, minimum height of 4 mm (0.15 in).

- .5 Graphical display will indicate the following at minimum. Coordinate between all trades for inclusion of this information.

- .1 "YOU ARE HERE" indicated in red (unique to each passive graphic location), and properly oriented to the viewer when standing in front of the graphic.

- .2 Zone colours to clearly indicate the extents of all fire alarm zones.

- .1 Define all egress corridors in a distinctive (dot) black hatch pattern.

- .2 All enclosed stairs and elevators to be coloured yellow.

- .3 Indicate the extents of zones served by air handling units with shut downs.

- .4 Indicate the location of the fire alarm control panel, all annunciators, and network panels/nodes.

- .5 Indicate the location of the ULC monitoring transmitter.

- .6 Indicate the location and designation of sprinkler and standpipe monitoring devices.

- .7 Indicate the location of Sprinkler Room(s), and all supervised fire protection devices. Coordinate with the fire protection trade(s) for exact locations of devices.

- .8 Emergency exit doors with door numbers shown. These will be needed to cross reference with the annunciator panel labels for pull stations that are activated next to these doors.

- .9 Label all Stair Letters. Designations to match Architectural drawings.

- .10 Main gas shut off location.

- .3 Frame

- .1 Extruded aluminum frame with concealed mounting hardware and concealed screws
- .2 Brushed silver finish.
- .3 Concealed security mounting hardware.
- .4 Frame to permit future replacement of graphic if the building or zone layouts change in future.
- .4 Allow for other requirements per the Authorities Having Jurisdiction, including the Municipal Building Inspector, and Municipal Fire Inspector.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Installation in accordance with Section 28 46 13.
- .2 Install annunciators and passive graphics with the top no greater than 1800 mm (70 in) above finished floor.
- .3 Install main annunciators with temporary passive graphics in the following locations:
 - .1 Ground floor lobby (firefighter's entrance).
 - .2 Other locations as noted on drawings.
- .4 Install temporary passive graphic at fire alarm control panel.

3.2 SITE TESTS AND INSPECTIONS

- .1 Review passive graphics and annunciators with municipal fire inspector on site during occupancy review. Incorporate any comments and resubmit to the Consultant for review.
- .2 Include reprogramming of zone nomenclature by system manufacturer to suit municipal review comments.
- .3 After review by the Consultant, fabricate final passive graphics, and replace temporary graphics on site.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 ULC monitoring equipment for fire alarm systems.

1.2 RELATED REQUIREMENTS

- .1 Section 28 46 13 – Fire-Alarm Systems.

1.3 REFERENCES

- .1 CAN/ULC-S559:2020, Standard for Equipment for Fire Signal Receiving Centres and Systems.
- .2 CAN/ULC-S561:2020, Installation and Services for Fire Signal Receiving Centres and Systems.

1.4 COORDINATION

- .1 Coordinate if the Owner has identified a ULC monitoring company to be used.
- .2 Coordinate the specific installation requirements of the monitoring panel supplier with the fire alarm system supplier.

1.5 SUBMITTALS

- .1 In accordance with Section 01 33 00, and Section 28 46 13.

1.6 CLOSEOUT SUBMITTALS

- .1 ULC "Fire Protective Signaling Certificate" certificate indicating the monitoring company is in compliance with CAN/ULC-S561.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 In accordance with Section 01 61 00.

PART 2 - PRODUCTS

2.1 ULC FIRE ALARM MONITORING PROVIDER

- .1 Owner's monitoring vendor to provide ULC monitoring transmitter adjacent to Fire Alarm Control Panel.

2.2 MANUFACTURERS

- .1 Johnson Controls / Tyco | DSC.
- .2 Substitutions: equal product from other manufacturers acceptable to the manufacturer of the fire alarm system, and the authority having jurisdiction.

2.3 TRANSMITTER PANEL

- .1 The Fire alarm system shall be provided with a fire alarm monitoring panel that meets ULC-S559 and ULC-S561 requirements. DSC Fire Alarm Monitoring System or approved equivalent.

- .2 The monitoring system shall support active communication or passive cell/IP communication.
- .3 Monitoring panel shall be certified for active or passive ULC monitoring and operate on the local cellular LTE networks.
- .4 Monitoring Panel shall have an LCD back lit display keypad with AC status indicator. Provide battery back-up for the monitoring panel and energize from a dedicated branch circuit. Provide a red lock-on device for the breaker.
- .5 Monitoring shall be provided in a passive configuration to meet ULC-S561 requirements. System shall have a dedicated primary telephone line and shall not be shared with any other system in the facility. Provide Category 6 voice and data cabling in EMT conduit to the telephone demark in the telecommunications entrance facility. Fire alarm system supplier shall be responsible to include a complete system with monitoring for two (2) years after substantial performance.
- .6 As part of the fire alarm system shop drawing submission provide information on the monitoring company and confirmation that the monitoring company meets ULC-S561 requirements.
- .7 The Monitoring System shall include cellular booster complete with lightning surge protector. Wilson Pro1050 or approved equivalent.
- .8 The Contractor is responsible for all wiring from the fire alarm panel to the monitoring panel and from the monitoring panel to the telecommunications entrance facility. Cabling shall be as per manufacturer's requirements. All cabling shall be run in conduit.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Locate monitoring transmitter adjacent to fire alarm control panel.
- .2 Provide one dedicated 15 A, 120 VAC circuit for monitoring transmitter.
- .3 Provide a junction box at the monitoring transmitter location with the fire alarm zone outputs from the Fire Alarm System to the monitoring transmitter.
- .4 Connect fire alarm system outputs to ULC monitoring transmitter.
- .5 Provide one data outlet to the ULC monitoring transmitter.
- .6 Post a copy of the ULC certificate at the location of the transmitter.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 End-of-Line Devices.
- .2 Fault Isolators.
- .3 Wire Guards.

1.2 RELATED REQUIREMENTS

- .1 Section 28 46 13 – Fire-Alarm Systems.
- .2 Section 28 46 31.31 – Fire-Alarm Manual Initiating Devices: manual pull station covers.

1.3 REFERENCES

- .1 CAN/ULC-S524-14 – Installation Standard for Fire Alarm Systems.

1.4 UNIT PRICES

- .1 Refer to Document 00 43 00.26.
- .2 Unit price to supply and install wire guard for any fire alarm device.

1.5 CLOSEOUT DOCUMENTS

- .1 As-Built Drawings: include location and zone of all End-of-Line devices.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Stock Materials
 - .1 Provide (supply and install) an additional [five] of each of the following devices as directed during construction. Turn over unused surplus in addition to those devices listed above:
 - .1 Fault Isolators.
 - .2 End-of-Line devices.
 - .3 Wire guard.
- .2 Spare Parts
 - .1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.
 - .1 Supply three of each type of other installed initiating, notification, or controlling devices.
- .3 Tools
 - .1 Supply three of each type of any special tools required for system use and maintenance.

PART 2 - PRODUCTS

2.1 END OF LINE DEVICES

- .1 One watt type resistors mounted within outlet boxes separate from those for other devices at the locations indicated. Provide on the cover plate for each such device on approved nameplate, engraved "END-OF-LINE RESISTOR" or with an approved symbol. Provide red lamacoid plate with white 6 mm letters identifying zone.

2.2 FAULT ISOLATORS

- .1 Module shall detect and isolate a short-circuited segment of a fault-tolerant loop whilst allowing the rest of the addressing circuit to function normally.

2.3 DEVICE GUARDS

- .1 Description: Welded wire mesh of size and shape for the initiation, signaling, or other device requiring protection.
 - .1 Factory fabricated and furnished by manufacturer of device.
 - .2 Finish: Paint of colour to match the protected device.
- .2 Pull station covers: as described in Section 28 46 31.31.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Installation to Section 28 46 13 and CAN/ULC-S524.
- .2 End-of-Line devices:
 - .1 Provide End-of-Line devices as directed by the manufacturer on Class B circuits.
 - .2 Install 1800 mm above finished floor in interior spaces and provide a label indicating the zone service.
 - .3 Installation of End-of-Line devices within other field devices: not permitted.
 - .4 Provide a permanent mark to identify the zone or circuit served by the End-of-Line device.
- .3 Fault Isolators:
 - .1 Provide fault isolators in accordance with CAN/ULC-S524.
- .4 Illuminated "Fire Do Not Enter" Signs
 - .1 Feed illuminated signs from the fire alarm system and provide electrically supervised output circuits.

3.2 FIELD TESTS AND INSPECTIONS

- .1 Testing and inspection to Section 28 46 13.
- .2 Verification to Section 28 46 13.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Spot Heat Detectors.
- .2 Spot Smoke Detectors.
- .3 Duct mounted smoke detectors.
- .4 Accessories.

1.2 RELATED REQUIREMENTS

- .1 Section 28 01 80.71 – Revisions and Upgrades of Fire Detection and Alarm.
- .2 Section 28 46 31.18 – Carbon Monoxide Detection Sensors.

1.3 UNIT PRICES

- .1 Refer to Document 00 43 00.26.
- .2 Submit with Tender unit prices to provide the following. Include installation and verification in the unit price:
 - .1 Fire detector (heat detector or smoke detector) complete with wiring and conduit, based on 10 metre distance.
 - .2 Duct type smoke detector complete with wiring and conduit on a separate zone, based on 30 metre distance.
- .3 Unit cost of additional conduit and wire for the above items.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Stock Materials:
 - .1 Provide (supply and install) an additional [five] of each of the following devices as directed during construction. Turn over unused surplus in addition to those devices listed above:
 - .1 Smoke detectors.
 - .2 Duct smoke detectors.
- .2 Spare Parts:
 - .1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.
 - .1 Supply three of each type of addressable detector base, smoke detector, heat detector, and fire alarm pull station.
 - .2 Supply three of each type of other installed initiating, notification, or controlling devices.
- .3 Tools:
 - .1 Supply three of each type of any special tools required for system use and maintenance.

PART 2 - PRODUCTS

2.1 AUTOMATIC CONVENTIONAL HEAT DETECTORS

- .1 Automatic heat detectors shall have a combination rate of rise and fixed temperature rated at 57.2 degrees C (135 degrees F) for areas where ambient temperatures do not exceed 37.7 degrees C (100 degrees F), and 93.33 degrees C (200 degrees F) for areas where the temperature does not exceed 65.5 degrees C (150 degrees F).
- .2 Automatic heat detectors shall be a low profile, ceiling mount type with positive indication of activation.
- .3 The rate of rise element shall consist of an air chamber, a flexible metal diaphragm, and a factory calibrated, moisture-proof, trouble free vent, and shall operate when the rate of temperature rise exceeds 9.4 degrees C (15 degrees F) per minute.
- .4 The fixed temperature element shall consist of a fusible alloy retainer and actuator shaft.
- .5 Automatic heat detectors shall have a smooth ceiling rating of 232 square metres (2500 square feet).
- .6 Style of detectors shall match existing system.

2.2 FIXED TEMPERATURE HEAT DETECTORS

- .1 Manufacturers:
 - .1 Basis of design: Potter CF series.
- .2 Features:
 - .1 Low profile design
 - .2 White plastic housing
 - .3 Up to 70' inter detector spacing
 - .4 Open or closed contact versions.
 - .5 Product includes a 5 year warranty.

2.3 COMBINATION RATE-OF-RISE AND FIXED TEMPERATURE HEAT DETECTORS

- .1 Manufacturers:
 - .1 Basis of design: Potter CR series.
- .2 Features:
 - .1 Low profile design
 - .2 White plastic housing
 - .3 Up to 70' inter detector spacing
 - .4 Open or closed contact versions.
 - .5 Product includes a 5 year warranty.

2.4 CONVENTIONAL PHOTOELECTRIC AREA SMOKE DETECTORS

- .1 Smoke detector shall be a System Sensor i3 Series, listed to ULC.

- .2 The detector shall be a photoelectric type (model C2W-BA for 2-wire, model C4W-BA for 4-wire).
- .3 The detector shall include a mounting base for mounting to 3½-inch and 4-inch octagonal, single gang, and 4-inch square back boxes with a plaster ring, or direct mount to the ceiling using drywall anchors.
- .4 Wiring connections shall be made by means of SEMS screws. The detector shall allow pre-wiring of the base and the head shall be a plug-in type.
- .5 The detector shall have a nominal sensitivity of 2.5 percent-per-foot nominal as measured in the ULC smoke box. The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The detector shall provide dual color LED indication which blinks to indicate power up, normal standby, out of sensitivity, alarm, and freeze trouble (Model C2WT-BA, C4WT-BA) conditions.
- .6 When used in conjunction with the C2W-MOD2A module, 2-wire models shall include a maintenance signal to indicate the need for maintenance at the alarm control panel, and shall provide a loop testing capability to verify the circuit without testing each detector individually.
- .7 The CSENS-RDRA, a wireless device, displays the sensitivity of i3 detectors in terms of percent per-foot-obscuration.
- .1 Supply one CSENS-RDRA in project for each project site.

2.5 CONVENTIONAL DUCT SMOKE DETECTORS

- .1 Duct smoke detectors shall be a 24 VDC type with visual alarm indicator, visual power indicator, and a reset switch. Each detector shall be installed upon the composite supply/return air ducts(s), with properly sized air sampling tubes.

2.6 CONVENTIONAL MANUAL PULL STATIONS

- .1 General Requirements for Manual Fire-Alarm Boxes: Comply with CAN/ULC-S528. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
- .2 Description: Conventional single-action type, red LEXAN. Station shall mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units. Station shall be pull-lever type; with integral terminal strip to accommodate wiring connections to fire-alarm control unit Initiating Device Circuit.
- .3 Indoor Protective Shield: none
- .4 Barrier Free Path of Travel: Where required, manual station shall be operable using a closed fist and with a force of not more than 22.2 N. Provides a more easily operated manual station compared to standard stations.
- .5 Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.
- .6 Manual fire alarm stations shall be non-coded, non-breakable glass type.
- .7 Stations must be designed such that after an actual activation, they cannot be restored to normal without the use of a special tool.
- .8 An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of 30.5 m (100 feet) front or side.

- .9 Manual stations shall be constructed of metal, with operating instructions provided on the cover. The word FIRE shall appear on the manual station in letters 12.7 mm (0.5 inch) in size or larger.
- .10 Provide polycarbonate vandal resistant covers for new manual pull stations.
- .11 Style of new manual pull stations to match existing system

2.7 ACCESSORIES

- .1 Relay Base.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Installation to Section 28 46 13.

3.2 IDENTIFICATION

- .1 Provide an engraved phenolic nameplate, red text on red background at the ceiling location below any concealed duct mounted smoke detectors indicating "Smoke Detector Above – DSD-1" where DSD-1 is the identification of the detector. Locate on lay-in ceiling grid or access hatch where located.

3.3 FIELD TESTS AND INSPECTIONS

- .1 Testing, and inspection to Section 28 46 13.
- .2 Verification to Section 28 46 13.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Sensors for the detection of Carbon Monoxide (CO) gas.

1.2 RELATED REQUIREMENTS

- .1 Section 28 46 13 – Fire-Alarm Systems.

1.3 REFERENCES

- .1 Ontario Building Code.
- .2 CAN/ULC-S529:2016 – Smoke Detectors for Fire Alarm Systems.

1.4 CERTIFICATIONS

- .1 The CO detector shall be ULC-S529 and CSA 6.19 as Carbon Monoxide alarm device.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 Edwards signature series “SIGA2” devices.
- .2 S-Tech.
- .3 CO detectors shall be compatible with the system in Section 28 46 13.

2.2 CARBON MONOXIDE SENSORS

- .1 The CO element shall be modular and can be replaced when the CO detector reaches end of life, so that the whole detector does not need to be replaced. Detectors that require the complete device to be replaced are not acceptable.
- .2 The CO detector element shall have an integral count-down timer that counts down from 6 years (expected life span of the CO detector component). The detector's processor shall monitor the CO detector component to ensure that if the CO device is out of tolerance before the 6-year time frame, the device will register a trouble condition and identify itself to the control panel.
- .3 Devices include, SIGA2-COS, carbon monoxide detector, SIGA2-PCOS, combination Photoelectric/CO detector, SIGA2-PHCOS combination Photo/Thermal/ CO detector as well as SIGA2-HCOS combination Heat/CO detector. The combination devices shall only utilize one detector address and have the ability to separate the device types to a maximum of two different inputs from each addressable detector. It shall be possible to have the smoke detector activate the sounder base only like a smoke alarm and have the heat detector activate the general alarm condition. And if the CO sensor activates, the sounder base must sound the ISO Temporal 4 CO alarm code.
- .4 The CO sensor in a sounder base shall be listed as a Carbon Monoxide Alarm to CSA-6.19. Addressable Carbon Monoxide (CO) Detector, EST model SIGA2-COS with audible sounder base. Provide intelligent addressable Carbon Monoxide Detector with Temporal 4 Audible Base.

- .5 The CO detection element shall indicate a trouble condition at the FACP signaling end of life and the CO element of the detector shall be field replaceable. It shall be programmed at the main control panel as a supervisory indication and transmit a separate supervisory signal to the central station.
- .6 Alternate product for mechanical rooms: S-Tech STCH-1000HW (hard wired alarm, wall mount), and STCH-100HWR (hard wired alarm with relay).

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Installation to Section 28 46 13.
- .2 Install CO detectors in accordance with 2012 Ontario Building Code, section 6.2.12, and as indicated on the drawings.
 - .1 Mechanical rooms.

3.2 SITE TESTS AND INSPECTIONS

- .1 Testing, and inspection to Section 28 46 13.
- .2 Verification to Section 28 46 13.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Intelligent Modules.
- .2 Fire Alarm Pull Stations for Single Stage Fire Alarm Systems.

1.2 RELATED REQUIREMENTS

- .1 Section 21 12 00 – Fire-Suppression Standpipes.
- .2 Section 21 13 00 – Fire-Suppression Sprinkler Systems.
- .3 Section 26 05 00 – Common Work Results for Electrical.
- .4 Section 28 46 13 – Fire-Alarm Systems.

1.3 REFERENCES

- .1 CAN/ULC-S528, Manual Stations for Fire Alarm Systems.

1.4 UNIT PRICES

- .1 Submit with Tender unit prices to provide the following. Include installation and verification in the unit price:
 - .1 Manual pull station, complete with wiring and conduit based on 10 metre distance.
 - .2 Unit cost of additional conduit and wire for the above items.
 - .3 Unit cost for supply and installation of pull station cover.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Stock Materials
 - .1 Provide (supply and install) an additional [zero](#) of each manual pull station to be used as directed on site during construction.
 - .2 Turn over unused surplus in addition to those devices listed below.
- .2 Spare Parts
 - .1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.
 - .1 Supply 6 keys of each type.
 - .2 Supply 3 of each type of fire alarm pull station.
 - .3 Supply 10 manual pull station break-glass rods.
- .3 Tools:
 - .1 Supply three of each type of any special tools required for system use and maintenance.

PART 2 - PRODUCTS

2.1 MICROPROCESSOR BASED INTELLIGENT MODULES

.1 General

- .1 Zone Addressable Modules (ZAM) shall be used for the monitoring of water flow, valve tamper, fire suppression control panels, non-addressable detectors, and for control of fans or dampers that require shutdown or manual control in an alarm condition.
- .2 Monitor ZAM's shall monitor any N/O contact device and be capable of powering 2-wire smoke detectors. The ZAM will communicate the zone's status (normal, alarm, trouble) to the transponder. The ZAM's zone address shall be set at the time of installation via a dip switch package.
- .3 Control ZAM's shall be able to provide supervised or non-supervised control of any control function. The ZAM will communicate the zone's status (normal, trouble) to the transponder. Each control ZAM shall provide a double pole double throw relay for switching loads of up to 120 VAC. Each common leg of the relay shall be equipped with a replaceable 2 Amp fuse. The ZAM's zone address shall be set at the time of installation via a dip switch package.
- .4 Fire Alarm / Life Safety System shall incorporate microprocessor-based addressable modules for the monitoring and control of system Input and Output functions over a 2-wire electronic communications loop, using both broadcast and serial polling protocols. All modules shall display communications and alarm status via LED indicators. The function of each connected module shall be determined by the module type, and shall be defined in the system software through the application of a personality code. All addressing of the Microprocessor-based Addressable Modules shall be done electronically, and the electrical location of each module shall be automatically reported to the Fire Alarm Control Panel, where it may be downloaded into a PC, or printed out. The addressing of the modules will not be dependent on their electrical location on the circuit. All field wiring to the Microprocessor-based Addressable Modules shall be supervised for opens and ground faults and shall be location identified to the module of incidence. Diagnostic circuitry, and their associated indicators, with reviewable Trouble Codes, shall be integral to the Microprocessor-based Addressable Modules to assist in troubleshooting system faults. Each module shall be suitable for operation in the following environment:

- .1 Temperature: 0°C to 49°C (32°F to 120°F).
- .2 Humidity: 0-93% RH, non-condensing.

.2 Single Input Module:

- .1 Microprocessor-based Addressable Modules shall be used to provide one (1) supervised Class A input circuit capable of latching operation for use with contact devices, non-damped Waterflow Switches, non-latching supervisory sprinkler switches.

.3 Dual Input Module:

- .1 Microprocessor-based Addressable Modules shall be used to provide two (2) independent supervised Class A input circuits capable of operation with contact devices. Both of the input circuits shall be terminated to, and operated from, the same microprocessor-based addressable module.
- .2 Modules configured for water flow operation shall have an automatic delay of 15 seconds before reporting the water flow alarm condition to the Fire Alarm Control Panel. The module shall monitor sprinkler supervisory switches and shall automatically report the supervisory function to the Fire Alarm Control Panel each time the associated dry contact closes.

- .4 Monitor Module:
 - .1 The Microprocessor-based Addressable Monitor Module shall be factory set to support one (1) supervised Class A Normally-Open Active Non-Latching Monitor circuit. The module shall automatically report the monitor function to the Fire Alarm Control Panel each time the associated dry contact closes.
- .5 Control Relay Module:
 - .1 Microprocessor-based Addressable Control Relay Modules shall provide one form "C" dry relay contact rated at 2 amps at 24 VDC or 0.5 amps at 120 VAC to, control external appliances or equipment processes. The control relay module shall be rated for pilot duty applications. The position of the relay contact shall be confirmed by the system firmware.

2.2 MICROPROCESSOR BASED ADDRESSABLE MANUAL PULL STATIONS

- .1 Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
- .2 Stations must be designed such that after an actual activation, they cannot be restored to normal without the use of a special tool.
- .3 All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
- .4 Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 44 mm (1.75 in) or larger.
- .5 All addressing of the Manual Pull Stations shall be done electronically, and the electrical location of each station shall be automatically reported to the Fire Alarm Control Panel, where it may be downloaded into a PC, or printed out. The addressing of the Manual Pull Station will not be dependent on their electrical location on the circuit.
- .6 The manual station shall be suitable for mounting on a North American 38 mm (1-1/2 inch) deep, 100 mm (4 inch) square electrical box with 13 mm (1/2 inch) raised cover.
- .7 All Manual Fire Alarm station shall be suitable for operation in the following environment:
 - .1 Temperature: 0 degrees C to 49 degrees C (32 degrees F to 120 degrees F).
 - .2 Humidity: 0-93 per cent RH, non-condensing.
- .8 Pull Station Cover
 - .1 All Manual Fire Alarm pull stations shall be provided with a clear, tamperproof, polycarbonate shield and frame that fits over manual pull stations. When lifted to gain access to the actual alarm, it shall sound a 95 dB or 105 dB warning horn.
 - .2 The cover is connected to the frame by a cable. When the cover is lifted, it hangs off of the frame and the horn will sound until the cover is snapped back onto the frame (or for the life of the battery).
 - .3 Battery shall be provided for each cover.
 - .1 Tamper or protecting covers for manual stations shall comply with CAN/ULC-S528, Including Accessories.
- .2 Red surface backbox
 - .1 Similar to Mircom BB-300, or Notifier BB series.

- .9 Pull stations shall be addressable, single action, non-coded, single stage, semi-flush mounted type.
- .10 Provide contacts for connection to magnetic locking devices power supply such that upon activation of the local pull station or first stage fire alarm signal the magnetic locks release.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Installation to Section 28 46 13.
- .2 Provide manual pull stations at the following locations:
 - .1 Near the principal entrance to the building.
 - .2 Near every required exit.
 - .3 At doors equipped with electromagnetic locks, locate on the wall not more than 600 mm from the door.
 - .4 Other locations as described in the Building Code.
- .3 Install manual pull stations at 1200 mm above finished floor.
- .4 Where possible, install the manual station on the latch side of a single door at a maximum lateral distance of 1500 mm (59 in) from the door opening.
- .5 Install manual pull stations on both sides of a series of doors exceeding 12 m (39 feet) in total width, and within 1500 mm (59 in) of each side of the opening.
- .6 When installing manual pull station on a glass partition mullion, provide red surface backbox for pull station, and fish armoured flexible cables through mullion of door frame.

3.2 SITE TESTS AND INSPECTIONS

- .1 Testing, and inspection to Section 28 46 13.
- .2 Verification to Section 28 46 13.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Intelligent modules.
- .2 Sprinkler room temperature sensors.

1.2 RELATED REQUIREMENTS

- .1 Section 21 13 00 – Fire-Suppression Sprinkler Systems.
- .2 Section 26 05 00 – Common Work Results for Electrical.
- .3 Section 28 46 13 – Fire-Alarm Systems.

1.3 UNIT PRICES

- .1 To Section 28 46 13.

1.4 REFERENCES

- .1 CAN/ULC-S524:2019, Standard for Installation of Fire Alarm Systems.
- .2 CAN/ULC-S548-15 (R2020), Standard for devices and accessories for water type extinguishing systems.
- .3 CAN/ULC-S573:2018, Standard for Installation of Ancillary Devices Connected to Fire Alarm Systems.
- .4 CAN/ULC-S1001-11, Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems.
- .5 NFPA 13, Standard for the Installation of Sprinkler Systems.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Stock Materials
 - .1 Provide (supply and install) an additional [five] of each of the following fire alarm devices as directed during construction. Turn over unused surplus in addition to those devices listed below:
 - .1 Zone Addressable Modules (ZAMs).
- .2 Spare Parts
 - .1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.
 - .1 Supply three of each type of other installed initiating, notification, or controlling devices.
- .3 Tools
 - .1 Supply three of each type of any special tools required for system use and maintenance.

PART 2 - PRODUCTS

2.1 MICROPROCESSOR BASED INTELLIGENT MODULES

.1 General

- .1 Zone Addressable Modules (ZAM) shall be used for the monitoring of water flow, valve tamper, fire suppression control panels, non-addressable detectors, and for control of fans or dampers that require shutdown or manual control in an alarm condition.
- .2 Monitor ZAM's shall monitor any N/O contact device and be capable of powering 2-wire smoke detectors. The ZAM will communicate the zone's status (normal, alarm, trouble) to the transponder. The ZAM's zone address shall be set at the time of installation via a dip switch package.
- .3 Control ZAM's shall be able to provide supervised or non-supervised control of any control function. The ZAM will communicate the zone's status (normal, trouble) to the transponder. Each control ZAM shall provide a double pole double throw relay for switching loads of up to 120 VAC. Each common leg of the relay shall be equipped with a replaceable 2 Amp fuse. The ZAM's zone address shall be set at the time of installation via a dip switch package.
- .4 Fire Alarm / Life Safety System shall incorporate microprocessor-based addressable modules for the monitoring and control of system Input and Output functions over a 2-wire electronic communications loop, using both broadcast and serial polling protocols. All modules shall display communications and alarm status via LED indicators. The function of each connected module shall be determined by the module type, and shall be defined in the system software through the application of a personality code. All addressing of the Microprocessor-based Addressable Modules shall be done electronically, and the electrical location of each module shall be automatically reported to the Fire Alarm Control Panel, where it may be downloaded into a PC, or printed out. The addressing of the modules will not be dependent on their electrical location on the circuit. All field wiring to the Microprocessor-based Addressable Modules shall be supervised for opens and ground faults and shall be location identified to the module of incidence. Diagnostic circuitry, and their associated indicators, with reviewable Trouble Codes, shall be integral to the Microprocessor-based Addressable Modules to assist in troubleshooting system faults. Each module shall be suitable for operation in the following environment:

- .1 Temperature: 0°C to 49°C (32°F to 120°F)
- .2 Humidity: 0-93% RH, non-condensing

.2 Single Input Module:

- .1 Microprocessor-based Addressable Modules shall be used to provide one (1) supervised Class A input circuit capable of latching operation for use with contact devices, non-damped Waterflow Switches, non-latching supervisory sprinkler switches.
- .3 Dual Input Module:
 - .1 Microprocessor-based Addressable Modules shall be used to provide two (2) independent supervised Class A input circuits capable of operation with contact devices. Both of the input circuits shall be terminated to, and operated from, the same microprocessor-based addressable module.
 - .2 Modules configured for water flow operation shall have an automatic delay of 15 seconds before reporting the water flow alarm condition to the Fire Alarm Control Panel. The module shall monitor sprinkler supervisory switches and shall automatically report the supervisory function to the Fire Alarm Control Panel each time the associated dry contact closes.
- .4 Monitor Module:
 - .1 The Microprocessor-based Addressable Monitor Module shall be factory set to support one (1) supervised Class A Normally-Open active non-latching monitor circuit. The module shall automatically report the monitor function to the Fire Alarm Control Panel each time the associated dry contact closes.
- .5 Control Relay Module:
 - .1 Microprocessor-based Addressable Control Relay Modules shall provide one form "C" dry relay contact rated at 2 amps @ 24 VDC or 0.5 amps at 120 VAC to, control external appliances or equipment processes. The control relay module shall be rated for pilot duty applications. The position of the relay contact shall be confirmed by the system firmware.

2.2 TEMPERATURE SWITCHES

- .1 To sense a temperature approaching the freezing point in any dry pipe valve enclosure or water storage container used for firefighting purposes.
- .2 Basis of design: Potter RTS series.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Installation to Section 28 46 13.
- .2 Provide temperature sensor in any room containing a dry pipe valve and connect to fire alarm system to indicate a supervisory signal on the building fire alarm system annunciator for a

temperature approaching the freezing point in any dry pipe valve enclosure or water storage container used for firefighting purposes.

3.2 SITE TESTS AND INSPECTIONS

- .1 Testing, and inspection to Section 28 46 13.
- .2 Verification to Section 28 46 13.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Fire Alarm Horns.
- .2 Fire Alarm Strobes.
- .3 Combination Horn/Strobes.
- .4 Boosters.

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 00 – Common Work Results for Electrical.
- .2 Section 28 46 13 – Fire-Alarm Systems.

1.3 UNIT PRICES

- .1 Submit with Tender unit prices to provide the following. Include installation and verification in the unit price:
 - .1 Fire alarm horn complete with wiring and conduit, based on 10 metre distance.
 - .2 Fire alarm strobe complete with wiring and conduit, based on 10 metre distance.
 - .3 Combination fire alarm horn/strobe complete with wiring and conduit, based on 10 metre distance.
 - .4 Unit cost of additional conduit and wire for the above items.

1.4 REFERENCES

- .1 CAN/ULC-S525:2016, Audible signaling devices for fire alarm and signaling systems, including accessories.
- .2 CAN/ULC-S526:2016, Visible signaling devices for fire alarm and signaling systems, including accessories.

1.5 SUBMITTALS

- .1 Booster battery calculations, booster power supply voltage drop calculations.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Stock Materials
 - .1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.
 - .1 Supply three of each type of signalling device used on the project.
- .2 Spare Parts
 - .1 Provide (supply and install) an additional [five] of each of the following devices as directed during construction. Turn over unused surplus in addition to those devices listed above:
 - .1 Fire alarm horn.

- .2 Fire alarm strobes.
- .3 Combination horn/strobes.
- .3 Tools
 - .1 Supply three of each type of any special tools required for system use and maintenance.

1.7 CERTIFICATIONS

- .1 All appliances which are supplied for the requirements of this specification shall be ULC listed.
- .2 All appliances of the same manufacturer as the Fire Alarm Control Panel specified to ensure absolute compatibility between the appliances and the control panels, and to ensure that the application of the appliances are performed in accordance with the single manufacturer's instructions.
- .3 Any appliances that do not meet the above requirements, and are submitted for use must show written proof of their compatibility for the purpose intended. Such proof shall be in the form of documentation from all manufacturers that clearly states that their equipment (as submitted) is 100% compatible with each other for the purpose intended.

PART 2 - PRODUCTS

2.1 HORNS

- .1 Vibrating horn: semi-flush mounted, 24 VDC, selectable 94 dBA or 98 dBA, suitable for installation in a standard electrical box.
- .2 Red enamel typical, or white enamel as indicated on the drawings, and as confirmed by the Owner.

2.2 MINI HORNS

- .1 Vibrating horn: semi-flush mounted, 24 VDC, 91 dBA, suitable for installation in a standard electrical box.
- .2 Red enamel typical, or white enamel as indicated on the drawings, and as confirmed by the Owner.

2.3 HORN-STROBES

- .1 Vibrating horn: semi-flush mounted, 24 VDC, selectable 94 dBA or 98 dBA, suitable for installation in a standard electrical box.
- .2 Red enamel typical, or white enamel as indicated on the drawings, and as confirmed by the Owner.
- .3 Provide horn-strobes where shown on plans and drawings. Strobe output shall be determined as required by its specific location and application from a family of 15/75 cd, 30 cd, and 110 cd devices. Strobes shall provide a synchronized flash.
- .4 Strobes shall be 24 VDC and ULC listed.
- .5 Strobe circuits shall be coordinated with audible circuits such that activation of an audible circuit results in activation of the companion strobe circuit. The strobe circuits shall be capable of being arranged such that they continue to operate in the event that the audible circuits have been silenced and remain operating until the FACP has been reset. Strobe circuits should also be

coordinated with the audible circuits such that they are zoned in the same manner as the audible circuits.

- .6 All strobes and combination horn strobes shall be mounted such that the bottom of the device is mounted 2000 mm (79 in) above the finished floor or 150 mm (6 in) below the ceiling, whichever is lower.

2.4 STROBES

- .1 Strobes shall be supplied where shown on plans and drawings. Strobe output shall be determined as required by its specific location and application from a family of 15/75 cd, 30 cd, and 110 cd devices. Strobes shall provide a synchronized flash.
- .2 Size strobe power supplies based on all strobes set at 75 cd with exact setting determined in the field to provide adequate visual signals in accordance with CAN/ULC-S524.

1.02 REMOTE BOOSTER POWER SUPPLIES

- .1 Power supply booster designed to extend power available to notification appliance circuits.
- .2 Enclosure: Steel, with lockable front panel allowing access to all interior components, surface mounted.
- .3 Functions: Contains circuits to monitor and charge batteries, control, and supervise four Class B appliance circuits, and monitor two controlling inputs from external sources.
 - .1 Configurable to operate at any one of three signaling rates, or to follow the main panel's notification appliance circuit.
 - .2 Trouble contact with 16-second delay.
- .4 Batteries: Two, sized for 24 hours of standby followed by 15 minutes of alarm.
- .5 Indicators: LEDs, one for each circuit, one for battery supervision, one for ground fault, and one for power.
- .6 Input: 120 volt circuit.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Installation to Section 28 46 13.
- .2 Strobe light output (candela) in accordance with CAN/ULC-S524-14:
 - .1 Table 5 – Light Output for Wall-Mounted Strobe Lights for Various Room Sizes:

Maximum Area of Coverage (m)	Minimum Light Output, Candela (Effective Luminous Intensity)		
	One Light per Area	Two Lights per Area	Four Lights per Area
6.10 x 6.10	15	Not allowable	Not allowable
8.53 x 8.53	30	15	Not allowable
9.14 x 9.14	34	15	Not allowable
12.2 x 12.2	60	30	15
13.7 x 13.7	75	60	30
15.2 x 15.2	94	60	30
16.5 x 16.5	110	60	30
18.3 x 18.3	135	95	30
21.3 x 21.3	184	95	60
24.4 x 24.4	240	135	60
27.4 x 27.4	304	185	95
30.5 x 30.5	375	240	95
33.5 x 33.5	455	240	135
36.6 x 36.6	540	305	135
39.9 x 39.9	635	375	135

.2 Table 6 – Light Output for Ceiling-Mounted Strobe Lights for Various Room Sizes:

Maximum Area of Coverage (m)	Minimum Light Output, Candela (Effective Luminous Intensity)	
	Maximum Mounting Height (m)	One Light
6.10 x 6.10	3	15
9.14 x 9.14	3	30
12.2 x 12.2	3	60
15.2 x 15.2	3	95
6.10 x 6.10	6	30
9.14 x 9.14	6	45
12.2 x 12.2	6	80
15.2 x 15.2	6	115
6.10 x 6.10	9	55
9.14 x 9.14	9	75
12.2 x 12.2	9	115
15.2 x 15.2	9	150

.3 Table 7 – Corridor Spacing Allocation for Ceiling or Wall-Mounted Strobe Lights:

Corridor Length (m)	Minimum Number of 15 cd Strobe Lights
0 – 9	1
10 – 40	2
41 – 70	3
71 – 100	4
101 – 130	5
131 - 160	6

3.2 SITE TESTS AND INSPECTIONS

- .1 Testing, and inspection to Section 28 46.21 11.
- .2 Verification to Section 28 46 13.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Fire alarm interfaces to other systems.

1.2 RELATED REQUIREMENTS

- .1 Section 26 32 13.16 – Gas-Engine-Driven Generator Sets.
- .2 Section 26 09 23 – Lighting Control Devices.

1.3 REFERENCES

- .1 Ontario Building Code.
- .2 CSA C282:19, Emergency Power Supply for Buildings.
- .3 CAN/ULC-S524:2019, Standard for Installation of Fire Alarm Systems.
- .4 CAN/ULC-S573:2018, Standard for Installation of Ancillary Devices Connected to Fire Alarm Systems.
- .5 CAN/ULC-S1001-11, Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.4 SUBMITTALS

- .1 Submit under provisions of Section 01 33 00.
- .2 Product Data: Manufacturer's data sheets on each product to be used, including:
 - .1 Preparation instructions and recommendations.
 - .2 Storage and handling requirements and recommendations.
 - .3 Installation methods.
- .3 Operating and Maintenance Data: Include operating, troubleshooting, maintenance, and repair instructions for each item, with lists of spare parts, if any, and name, address, and phone number of local stocking distributors.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- [.1 intentionally deleted](#)

1.6 QUALITY ASSURANCE

- .1 Installer Qualifications: experienced door hardware installer.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Store products in manufacturer's unopened packaging until ready for installation.

1.8 WARRANTY

- .1 Provide manufacturer's standard warranties:
 - .1 Magnets: Lifetime warranty.

PART 2 - PRODUCTS

2.1 SYSTEM INTERFACES

- .1 Emergency Power Systems:
 - .1 Provide a Supervisory input for Emergency Power Supply supervisory contacts as follows:
 - .1 Generator Common Alarm.
 - .2 Automatic Transfer Switch "Not in Auto".
 - .2 Provide a monitoring input for Emergency Power supply contacts as follows that provides status indication but does not cause an audible alert, and automatically resets:
 - .1 Generator running.
- .2 Provide relays to interface with the following systems upon fire alarm signal:

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Do not begin installation until substrates have been properly prepared.
- .2 If substrate preparation is the responsibility of another installer, notify Consultant of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- .1 Clean surfaces thoroughly prior to installation.
- .2 Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Test for proper operation with building power energized; coordinate with start-up procedures of other installers.

3.4 SITE TESTS AND INSPECTIONS

- .1 Perform functional test in accordance with CAN/ULC-S1001 and Section 28 08 46 to confirm that systems operate as described. Perform test in the presence of the Contractor, sub-trades, Consultant, and applicable vendors.

3.5 PROTECTION

- .1 Protect installed products until completion of project.
- .2 Repair or replace damaged products before Substantial Performance.

- .3 Three bound copies which summarize the training instruction shall be submitted to the Owner for future reference.

END OF SECTION

SECTION INTENTIONALLY DELETED

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Shutdown relays.
- .2 Smoke Control.

1.2 RELATED REQUIREMENTS

- .1 Section 23 30 00 – HVAC Air Distribution.
- .2 Section 23 34 00 – HVAC Fans.
- .3 Section 28 46 13 – Fire-Alarm Systems.
- .4 Section 28 46 31 – Fire-Alarm Initiating Devices: duct mounted smoke detectors.

1.01 REFERENCES

- .5 Ontario Building Code.
- .6 CAN/ULC-S524:2019, Standard for Installation of Fire Alarm Systems.
- .7 CAN/ULC-S573:2018, Standard for Installation of Ancillary Devices Connected to Fire Alarm Systems.
- .8 CAN/ULC-S1001-11, Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.3 SUBMITTALS

- .1 Submit under provisions of Section 01 33 00.
- .2 Product Data: Manufacturer's data sheets on each product to be used, including:
 - .1 Preparation instructions and recommendations.
 - .2 Storage and handling requirements and recommendations.
 - .3 Installation methods.
- .3 Shop Drawings: Door Schedule showing each item of hardware to be installed on each door.
 - .1 Use door numbers on door schedule.
 - .2 Schedule may be combined with submittals required in other door hardware sections.
- .4 Operating and Maintenance Data: Include operating, troubleshooting, maintenance, and repair instructions for each item, with lists of spare parts, if any, and name, address, and phone number of local stocking distributors.

1.4 QUALITY ASSURANCE

- .1 Installer Qualifications: experienced door hardware installer.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Store products in manufacturer's unopened packaging until ready for installation.

1.6 WARRANTY

- .1 Provide manufacturer's standard warranties:
 - .1 Magnets: Lifetime warranty.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 General Requirements: Provide devices suitable for door type, lock type, frame type, dimensions, and overall operation.
 - .1 Coordinate with doors, frames, and hardware specified in other sections.
 - .2 Provide all brackets, spacers, shims, lip extensions, strike boxes, and other accessory parts necessary to complete the installation.
 - .3 Power Supplies or Transformers: Provide all necessary components to supply power to devices from building power distribution system.

2.2 AIR HANDLING UNIT SHUTDOWN RELAYS

- .1 Not used.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Do not begin installation until substrates have been properly prepared.
- .2 If substrate preparation is the responsibility of another installer, notify the Consultant of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- .1 Clean surfaces thoroughly prior to installation.
- .2 Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Coordinate with installers of other door hardware.
- .3 Adjust installed items to operate properly without interfering with operation of door and other hardware.
- .4 Test for proper operation with building power energized; coordinate with start-up procedures of other installers.

3.4 SITE TESTS AND INSPECTIONS

- .1 Perform functional test to confirm that held doors release upon smoke detection.

3.5 PROTECTION

- .1 Protect installed products until completion of project.
- .2 Repair or replace damaged products before Substantial Performance.
- .3 Three bound copies which summarize the training instruction shall be submitted to the Owner for future reference.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Automatic door controls for restrooms.
- .2 Emergency call systems for universal and barrier-free restrooms.
- .3 Automatic door relay controls.
- .4 Automatic door activation.
- .5 Automatic door wireless activation.

1.2 RELATED REQUIREMENTS

- .1 Section 08 71 00 – Hardware: requirements for door operators and electric strikes interconnected with this equipment.
- .2 Section 26 05 00 – Common Work Results for Electrical.

1.3 REFERENCES

- .1 ANSI A117.1 - Accessible and Usable Buildings and Facilities.
- .2 ANSI A156.19 - Standard for Power Assist and Low Energy Power Operated Doors.
- .3 Ontario Building Code 2012, section 3.8.3.12.(2) – Universal Washrooms.

1.4 SUBMITTALS

- .1 Submit under provisions of Section 01 33 00 – Submittal Procedures.
- .2 Product Data: Manufacturer's data sheets on each product to be used, including:
- .3 Preparation instructions and recommendations.
- .4 Storage and handling requirements and recommendations.
- .5 Installation methods.
- .6 Shop Drawings: Electrical schematic, device mounting requirements and rough-in for recessed devices.
- .7 Verification Samples: For each finish product specified, two samples, minimum size 150 mm (6 in) square representing actual product, color, and patterns.

1.5 CLOSEOUT SUBMITTALS

- .1 Functional test report.
- .2 Training attendance records.

1.6 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Minimum 5 year experience manufacturing similar products.
- .2 Installer Qualifications: Minimum 2 year experience installing similar products.
- .3 Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.

- .1 Finish areas designated by Architect.
- .2 Do not proceed with remaining work until workmanship is approved by the Consultant.
- .3 Rework mock-up area as required to produce acceptable work.

1.7 PRE-INSTALLATION MEETINGS

- .1 Convene minimum two weeks prior to starting work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.
- .2 Handling: Handle materials to avoid damage.

1.9 PROJECT CONDITIONS

- .1 Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by the manufacturer for optimum results. Do not install products under environmental conditions outside the manufacturer's recommended limits.

1.10 SEQUENCING

- .1 Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.11 WARRANTY

- .1 Manufacturer's Warranty: Provide manufacturer's warranty for defective parts for a three-year period from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 Camden Door Controls (basis of design).
- .2 Substitutions: Thomas Door & Security Hardware, TA-3230C-KIT.

2.2 EMERGENCY CALL SYSTEMS FOR UNIVERSAL RESTROOMS

- .1 Performance:
 - .1 Emergency Call System shall comply with the latest requirements of the Ontario Building Code (OBC), effective January 1, 2015.
 - .2 Emergency Call System shall be designed to provide a washroom occupant with the ability to request emergency assistance, to receive visual and audible confirmation that their request has been made, and visual and audible notification to building staff and occupants outside the restroom of an emergency condition.
- .2 Product: Emergency Call Systems For Universal and Barrier Free Restrooms – CX-WEC10K2 System as manufactured by Camden Door Controls.

- .1 Operation: the 'Press For Emergency Assistance' mushroom push button is activated by the occupant. This energizes the LED annunciator and sounder within the washroom and the dome light with sounder outside the washroom. Both annunciators will be energized until the latching mushroom push button switch is pulled out.
- .2 Components:
 - .1 The following items are part of the CX-WEC10K2 equipment package:
 - .1 CM-AF540SO Double gang, push/pull mushroom push button, red, 'Assistance Required', w/ LED annunciator and adjustable sounder, 'Assistance Requested'.
 - .1 'Press for Emergency Assistance' switch, 'Push/Pull' operation 41.27 mm (1-5/8") vandal resistant red button, N/O and N/C contacts, rated 10 Amp @ 30 VDC and permanently laser etched graphics (black).
 - .2 Single gang LED annunciator with adjustable sounder rated 85 dB at 102 mm (4 in), weather and vandal-resistant construction, brushed stainless steel faceplate, with 'ASSISTANCE REQUESTED'. 'White Out' text shall not be legible unless the annunciator is energized.
 - .3 Heavy gauge stainless steel double gang faceplate.
 - .2 CM-AF141SO: Single gang LED dome light with adjustable piezo sounder, rated 93 dB at 1 m (3 feet), weather (indoor/outdoor) and vandal resistant construction, white. 180 degree visibility with 'ASSISTANCE REQUIRED' text printed on two sides of the lens.
 - .3 CM-SE21A: sign, to be located above the activation switch, 1.6 mm (1/16 in), 152 mm high by 270 mm wide (6 in by 10-5/8 in), fire-rated expanded PVC white with 25 mm (1 in) red lettering. The text shall be "IN THE EVENT OF AN EMERGENCY PUSH EMERGENCY BUTTON AND AUDIBLE AND VISUAL SIGNAL WILL ACTIVATE".
 - .2 The following items are required, but not included in the CX-WC11 equipment package:
 - .1 CX-PS13 24V linear power supply and CX-TRX-4024 UL listed 40 VA transformer.
 - .2 Electric Strike: CX-ED2079 ('Universal' Grade 2 Electric Strike).
 - .3 Contact for Pushbutton (normally closed CM-4000/61N).
 - .4 Door contact.

2.3 AUTOMATIC DOOR CONTROLS FOR RESTROOMS

- .1 Performance:
 - .1 Automatic door controls shall comply with Americans with Disability Act.
 - .1 Regulatory compliance with Accessibility Guidelines (ADAAG) and the Uniform Federal Accessibility Standard (UFAS) as required by Authority Having Jurisdiction (AHJ).
 - .2 Automatic door controls shall comply with National Building Code of Canada.

- .3 Automatic door controls shall comply with NFPA National Fire Code or International Fire Code for restroom doors acting as egress doors as required by Authority Having Jurisdiction (AHJ).
- .4 Emergency Power: System shall be provided with an emergency power connection.
- .2 Product: Push Button and Annunciator Restroom Control System - CX-WC11 as manufactured by Camden Door Controls.
 - .1 Operation:
 - .1 The door is normally closed and either locked or unlocked. Pressing the exterior push plate unlocks and opens the door. Once inside and the door is closed, pressing the 'Push to Lock' mushroom pushbutton locks the door, disables the exterior 'Push to Open' push plate switch and illuminates the exterior annunciator to show 'Occupied when Lit'. Pressing the interior push plate switch unlocks the door, deactivates the illuminated annunciator, and resets the system. If the door is opened manually to exit the restroom, the overhead magnetic contact switch resets the system.
 - .2 Status: Normally locked. Fail secure electric strike.
 - .3 Status: Normally unlocked. Fail safe electric strike.
 - .2 Components:
 - .1 The following items are part of the CX-WC11 equipment package:
 - .1 CX-33PS includes Advanced Logic Control Relay and 2 Amp Power Supply in pre-wired metal cabinet.
 - .2 CM-45/4 114 mm (4.5 in) square activation (wall) switch (2 required), stainless steel construction, N/O contacts rated 15 Amps @ 30 VDC and paint filled debossed 'wheelchair symbol and 'Push To Open' graphics (blue). Mounted on in-wall single gang electrical box.
 - .3 CM 400/8 'Push to Lock' Mushroom Push Button with heavy duty brushed stainless steel faceplate, 40 mm (1-5/8") vandal resistant red button and N/O contacts rated 10 Amps @ 30 VDC.
 - .4 CM-AF500 Single Gang LED Annunciator, with heavy duty 18 gauge, vandal resistant stainless steel faceplate, 'Occupied When Lit' 'white out' text, super-bright LEDs, 10 VDC to 36 VDC voltage, max. 40 mA current draw.
 - .5 CX-MDA surface mount SPST N/C Magnetic Door Contact.
 - .6 CX-ED2079 Electric Strike, grade 2 'universal' strike for cylindrical locksets c/w 3 faceplates, 12/24V AC/DC, selectable fail safe/fail secure. The strike shall have horizontal faceplate adjustment.
 - .2 The following items are required, but not included in the CX-WC11 equipment package:
 - .1 CX-PS13 12/24V linear power supply and CX-TRX-4024 UL listed 40 VA transformer.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Do not begin installation until substrates have been properly prepared.

- .2 If substrate preparation is the responsibility of another installer, notify the Consultant of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- .1 Clean surfaces thoroughly prior to installation.
- .2 Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
 - .1 Install push button and the red "assistance requested" annunciator ganged together adjacent to the toilet.
 - .2 Install the emergency push button adjacent to the toilet, and post the sign above the emergency button.
 - .3 Install the dome light at exterior of the universal washroom, above the door of the washroom.
 - .4 Install conduit between system components, and install wiring as directed by manufacturer.
- .2 Provide all low voltage control wiring between system components.

3.4 FIELD QUALITY CONTROL

- .1 Perform test of system in the presence of the Owner. Submit report documenting the test was completed.

3.5 DEMONSTRATION AND TRAINING

- .1 Manufacturer's representative shall provide on-site training of staff and maintenance of operation, maintenance and "trouble/error" detection/correction.

3.6 PROTECTION

- .1 Protect installed products until completion of project.
- .2 Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION